



Jouni Laine

# REDESIGN OF TRANSFER CAPABILITIES

– STUDIES IN CONTAINER SHIPPING SERVICES

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HELSINKI SCHOOL OF ECONOMICS

ACTA UNIVERSITATIS OECONOMICAE HELSINGIENSIS

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## **ABSTRACT**

Traditionally transportation and materials handling services have been organized along the transport modes, but today the logistics service concepts address more directly the needs of typical customers and the efficiency of the whole integrated transportation chain. We have witnessed during the last thirty years the introduction of international parcel services, intermodalism and lines of huge container ships, value added services provided by third parties, and mega carriers integrating local and regional postal and private cargo services in land, sea and air. In the context of supply chain management, transfer capabilities mean the collective abilities of the industry to provide cargo handling, warehousing and transportation services dealing with the economies of scale and scope of routes, facilities and organizations, and the costs of actually serving customer. Despite the prevalence of integrated multimodal services in practice there are no matching theoretical models of general transfer capabilities available for the analysis of the logistics services sector.

Recognizing the tremendous change taking place in the transportation sector through globalization, deregulation, telecommunication and standardization, this thesis is targeting novel conceptual and operational approaches in the development of transfer capabilities and service solutions and to find generalized principles for strategic level structures and efficient operation to be applied over the entire physical transfer chain. The normative framework developed for the classification and analysis of physical transfer capabilities defines different types of transport and materials handling needs and business organizations that provide the delivery channels for the transfer services. By describing the long term changes of transfer services and the associated public and market institutions, an efficient matching of different transfer capabilities with various existing and new types of channel organizations can be determined in general, and with particular concern for the technological and organizational innovations in container shipping which is used as a test environment. The investigation involves in addition to sea transportation and port operations also the land transportation phases and terminal handling in the container transportation chain. Advanced solutions and operational practices are searched by examining the organizational models with strong emphasis on the role of standardization and cargo handling, transportation and information

technology as well as the redesign of the technological and organizational interfaces. The influence of economic development trends and globalization to transfer services is reviewed.

The first contribution of the thesis is a new conceptual framework - Transfer Service Matrix (TSM) - for classifying different transportation and material handling needs and types of organizational channels to position current practices and to visualize future development of transfer services. The second contribution comes from the use and testing of the TSM for analysis and illustration of potential structures for container transfer in case studies of operational and technological development in ports, where interviews and practical investigations are also supported with mathematical and simulation models. The third contribution is the discussion of the various organizational challenges when implementing networked business models and interlinked transfer chains. The managerial implications deal with the organizational and channel redesign issues required for the conservative industry to really bring the technological and operational process innovations to serve the customers.

**Keywords:** Transportation, Container shipping, Transport and material handling services, Port operations, Redesign of transfer capabilities

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# Table of Contents

<b>Abstract</b>	<b>i</b>
<b>1 Introduction .....</b>	<b>1</b>
1.1 Some Issues in the Analysis of Transfer Services.....	3
1.2 Research Problem and Objectives .....	5
1.3 Methodological Issues and Research Methods Used .....	8
1.3.1 Approaches in Logistics and Supply Chain Management Research .....	8
1.3.2 The Applying of the Methodologies in the Dissertation .....	11
1.4 The Organization of the Thesis.....	16
<b>2 Structural Analyses of Transfer Capabilities.....</b>	<b>18</b>
2.1 Leverage of Transportation.....	18
2.2 Demand and Supply of Transportation and Related Services .....	20
2.3 External Factors and Forces of Change .....	23
2.3.1 Geographical Specialization and Globalization.....	24
2.3.2 Technology and Physical Structure .....	25
2.3.3 (De)regulation in Transportation and Trade .....	28
2.3.4 Organizational Channels.....	29
2.4 The Influence of Development Forces and Innovations.....	30
2.5 Configuration of Transfer Chain.....	35
2.5.1 Activities of Physical Transfer Flows.....	35
2.5.2 Different Transportation Modes.....	38
2.6 Matching the Elements in Transfer Chains .....	43
2.6.1 The Diversified Dynamics of Transfer Chains .....	43
2.6.2 Compatibility in Organizational Interfaces .....	46
2.6.3 Overcoming the Compatibility Challenges.....	48
2.6.4 Vision - The Supply Chains of the Future .....	51

<b>3</b>	<b>Analyzing Physical Transfer Services.....</b>	<b>57</b>
3.1	Literature of Models for Transfer Services .....	58
3.2	Specifying the Transfer Services Matrix .....	61
3.2.1	Essential Elements of Physical Transfer .....	61
3.2.2	Types of Transfer Needs.....	63
3.2.3	Types of Transfer Channels .....	64
3.2.4	The Transfer Service Matrix.....	68
3.2.5	The Generic Transfer Service Solutions.....	70
3.3	Utilization of the Transfer Service Model .....	73
<b>4</b>	<b>Development of Container Transportation within Physical Distribution.....</b>	<b>75</b>
4.1	Development Phases of Physical Distribution .....	75
4.1.1	Self-sufficiency Economy and Pre-Industrial Development Stage .....	76
4.1.2	Production Driven Economy.....	78
4.1.3	Demand Driven Economy .....	79
4.1.4	Distribution Driven Economy.....	81
4.2	Illustration of the Future Physical Transfer Services.....	84
4.2.1	The Era of New Focus? .....	85
4.2.2	The “Sweet Spot of Change” .....	91
4.3	Container Transportation .....	95
4.3.1	The Past Development to Current in Container Shipping.....	95
4.3.2	The Features of Containerization .....	104
4.4	Prospects for Future Development in Container Shipping .....	108
4.4.1	Development Trends and Needs in Container Transfer .....	110
4.4.2	Organization in Container Shipping.....	114
4.4.3	Container Shipping Service Portfolio.....	118
4.4.4	The Scopes of Service Portfolios in the Future Container Transfer .....	120
<b>5</b>	<b>Transfer Performance of a Shipping Company....</b>	<b>126</b>
5.1	The Impact of Technology Investments in Profit-Making Potential.....	127
5.2	Illustration of Investment Tradeoffs.....	131
5.2.1	Model for Comparing Loading Speed and Cruising Speed.....	131
5.2.2	Alternative Technology Investments for Economies of Speed .....	132
5.2.3	The Trade-Off between Loading Speed and Cruising Speed .....	133
5.2.4	The Impact of Ship Capacity .....	136



5.3	A Framework of Shipping Economics.....	139
5.4	Technology Solution Case Study - <i>Twinstar</i> .....	143
5.4.1	Economical Implications .....	143
5.4.2	Structural Implications.....	146
<b>6</b>	<b>Improving of Port Efficiency.....</b>	<b>149</b>
6.1	Port in Transportation .....	149
6.2	Mechanization and Automation of Port Operations .....	152
6.3	Capacity Balancing of Port Operations .....	156
6.4	Organizational Solution Case Study - Helsinki West Harbour .....	160
6.4.1	Traffic and Capacity .....	160
6.4.2	Modeling and Simulations of the Case .....	163
6.4.3	The Investigation and Simulation Results.....	167
6.5	Technology Solution Case Study - Widespan Ship-to-Shore Gantry Crane .....	173
<b>7</b>	<b>Research Results and Discussion .....</b>	<b>177</b>
7.1	Summary of the Theoretical Results.....	177
7.2	Discussion .....	180
<b>8</b>	<b>Conclusions and Future Research .....</b>	<b>185</b>
8.1	Managerial Implications .....	185
8.2	Topics of Future Research.....	190
8.2.1	Development Needs of the Transfer Services Matrix .....	190
8.2.2	Other Future Research Topics .....	193

## References

## List of Figures

Figure 2-1	Landed Cost with Old and New Transport System (Coyle et al. 1994).....	19
Figure 2-2	Lardner's Relevant Areas (Coyle et al. 1994).....	20
Figure 2-3	A Model of Strategic Behavior in the Container Transport Industry (Brooks et al. 1993) .....	23
Figure 2-4	Some Characteristics of Different Transfer Services.....	32
Figure 2-5	Some Characteristics of Different Governance Structures.....	33
Figure 2-6	Types of Physical Product Flows (modified van Damme and van Amstel 1996) .....	36
Figure 2-7	The Simplified Entire Transportation Chain with Different Kinds of Product Flows, Transportation Legs, and Source and Destination Parties Involved .....	37
Figure 2-8	Matching supply chains with products (Fisher 1997) .....	44
Figure 2-9	The Benefit Development in Supply Chain Evolution (Andersen Consulting 2002) .....	55
Figure 3-1	The Transfer Service Matrix with Example Logistics Solutions .....	66
Figure 3-2	The generic transfer service solutions .....	71
Figure 4-1	The Development Stages of Distribution – the Slow and Rapid Waves of Development (Haapanen and Vepsäläinen 1999).....	75
Figure 4-2	Early Developments of Transfer Services.....	77
Figure 4-3	Previous Polarization of Transfer Services .....	82
Figure 4-4	Lately Inventions and Drivers in Transfer Services .....	83
Figure 4-5	Forces Influencing to Transfer Services - and Illustrated Results.....	89
Figure 4-6	Growth of General Cargo (Alderton and Rowlinson 2002).....	97
Figure 4-7	Growth in World Container Traffic (Alderton and Rowlinson 2002).....	97
Figure 4-8	Development of General Cargo Handling Performance (Wijnolst et al. 1994) .....	101
Figure 4-9	The Incompatibilities in the Interfaces between Organizations in Container Transport Chains (Bask and Laine 2000).....	113
Figure 4-10	Range of Strategic Alliances in the Container Transport Industry (Brooks et al. 1993) .....	115
Figure 4-11	Influence of Strategic Alliances and Ownership in Container Shipping Services.....	117
Figure 4-12	Splitting of Door-to-Door Container Transfer Portfolio.....	118
Figure 4-13	The Container Transport Chains of the Future (Bask and Laine 2000).....	121
Figure 4-14	General Cargo in Port Terminal-to-Port Terminal FCL Transfer .....	122
Figure 4-15	General Cargo in Terminal-to-Terminal FCL Transfer .....	123
Figure 4-16	General Cargo in Door-to-Door FCL Transfer .....	124
Figure 4-17	General Cargo in Production Line-to-Customer FCL Transfer .....	125

Figure 5-1	Technology Investment Opportunities for Economies of Speed in Shipping (Laine and Vepsäläinen 1994).....	128
Figure 5-2	Service Frequency Curves as a Function of Loading Speed and Cruising Speed - Coastal European Shortsea (Route 2000 nm), 1000 TEU (Laine and Vepsäläinen 1994).....	134
Figure 5-3	Service Frequency Curves as a Function of Loading Speed and Cruising Speed - Trans-Atlantic (Route 9000 nm), 2500 TEU (Laine and Vepsäläinen 1994).....	136
Figure 5-4	The Leverage of High-Speed Loading in Service Frequency Achieved by Higher Cruising Speed for Ships of 500 and 1000 Capacity (TEU), 2000 nm Route (Laine and Vepsäläinen 1994).....	138
Figure 5-5	Framework for Technology Investments and Economies of Speed in Shipping (Laine and Vepsäläinen 1994).....	141
Figure 5-6	Twinstar Profit Sensitivity for Cargo Handling Rate and Ship Size.....	145
Figure 5-7	Crossing the Interfaces - the Case of Twinstar Technology.....	147
Figure 5-8	The influence of Self-Loading Technologies (and Secondary Cargo Handling Automation).....	148
Figure 6-1	Transition in Port Work after the 1950's (Ojala 1991).....	153
Figure 6-2	Demand Fluctuations in the Interaction of Crane and Background Cargo Handling – Alternatives in Practice in Ship Unloading.....	158
Figure 6-3	Crane Capacity and Demand of Services at the Saukko Quay in the West Harbour of Helsinki (Esko Poltto Oy 1993, modified).....	161
Figure 6-4	Investigated System of Container Movements in the Helsinki West Harbour, in spring 1994.....	164
Figure 6-5	Cargo Transfer between Crane and Background Equipment.....	167
Figure 6-6	Operational Management Innovation – Asynchronous Crane Handling.....	172
Figure 6-7	Crossing the Interfaces - the Case of Widespan Crane Technology.....	175
Figure 6-8	Influence of the Widespan Crane Technology.....	176
Figure 7-1	The Likely Influence of Globalization and Deregulation in the Type of Transfer Services.....	180
Figure 7-2	The Likely Influence of Adapted Organizational and Technological Innovation in Transfer Services.....	181
Figure 7-3	The Field of the Most Significant Changes in Transfer Services?.....	184

# List of Tables

Table 2-1	Ranking of Transportation Modes (Coyle et al. 1996).....	39
Table 4-1	Transportation Trends (Coyle et al. 1994).....	85
Table 4-2	World Containerships Fleet in Operational Categories in 2000 (Alderton and Rowlinson 2002).....	99
Table 4-3	Standardized ISO-Container Sizes (Wijnolst et al. 1993).....	106
Table 4-4	Development trends of intermodal transport (Ministry of Transport & Communications, Finland, 1998).....	111
Table 4-5	Main Future Development Needs in Container Transport Chains.....	112
Table 5-1	Performance of Self-loading Twinstar (TWS) and a Conventional Container Ship (Cont.) - Comparative Simulation Results.....	144
Table 6-1	Comparison of Utilization of Resources between Two Different Types of Terminals (Port of Helsinki 1994; interview Boe 1994).....	162
Table 6-2	Simulation Results for Alternative Cargo Handling Solutions in the Helsinki West Harbour / Widespan Crane Performance. ....	171

# List of Equations

Equation 1	Roundtrip time .....	131
Equation 2	Transportation frequency.....	131



# 1 Introduction

By many accounts, transport is one of the four cornerstones of globalization along with telecommunications, trade liberalization and international standardization, upon which companies and nations have built the increasing efficiency of product sourcing and trading. More specifically, modern port and shipping services have made it ever easier to deliver merchandise goods, raw materials and components almost anywhere in the world. At the same time, maritime business itself has turned into one of the most globalized industries (Kumar and Hoffmann 2002). By other accounts, the forces that influence the direction and rate of change most economic activities, including transportation, are globalization of trading patterns, use of new technologies (the container, faster ships, internet) and deregulation of transportation (Muller 1999). These forces have an impact on the capabilities of transportation industry to provide intermodal transportation services (mixing different modes of traffic, cargo handling and warehousing, distribution, and communication) and often revive a fourth element forcing organizational changes in business (Coyle et al. 1994). We call transfer capabilities the collective abilities of the industry to provide cargo handling and transportation services. In the context of supply chain management, transfer capabilities are seen to bridge two types of gaps between consumers and producers, namely the time gap managed by the warehousing process and the geographical gap requiring physical transportation (Benson et al. 1994). Transfer capabilities as the subject matter of this thesis will be viewed predominantly managerially emphasizing the structural efficiency of operations, dealing with the economies of scale and scope of routes, facilities and organizations, the costs of actually serving customer, and the demand and price customers are willing to pay for different services.

International standardization has also closely affected shipping and the use of standard containers alone has been one of the most important technological changes in cargo handling and transportation with major impacts on costs, factor proportions and productivity. Any liner shipping company anywhere in the world can now easily enter new markets and provide its services globally (Kumar and Hoffmann 2002). Containerized transportation represents remarkable volumes especially in deep-sea shipping (intercontinental transportation) and is growing more rapidly than seaborne trade in general. During the period between 1994 and 2002, containerization of seaborne

trade has increased from 8.8% to 10.1% of all seaborne trade, and from 17.2% to 18.1% as a proportion of dry cargo only. Typically containerized cargoes consist of items of relatively higher value than in most other forms of sea trade but the use of containers also for cheaper bulk cargoes is increasing which offers additional growth potential and economic significance for this traffic mode. The expanding global trade due to the strong economic activity especially in China and India is case in point - in Hong Kong, the number of containers handled annually went up by 7.3% to a world record 21.9 million TEU's (TEU = Twenty feet Equivalent Unit, standardized ISO-container) in 2004, and PSA International, operator in the second busiest port in Singapore reported 14.1% increase in volumes to 20.6 million TEU's, and a competitor Port of Tanjung Pelepas in Malaysia matched growth by 15% to 4.02 million TEU's (The Straits Times 2005A, 2005B).

Competing with maritime transport mainly on international routes, however, is air cargo with the highest growth rate of all modes reflecting, according to Kumar and Hoffmann (2002), the globalization of the markets for higher valued products with shorter life cycles and components used for Just-In-Time delivery. In addition to the capabilities for faster (air-) transport companies in general are facing a multitude of requirements simultaneously. They should be cost efficient, flexible concerning capacity issues and produce with quality and speed a variety of services or goods in local, regional and global scale. This is hardly possible for every single involved operator in the business. Tan and Gwee (2002) conclude that blending global manufacturing, just-in-time (JIT) production and a very short time-to-market calls for integrated solutions with regional coverage and new value-added and third party logistics services such as reverse logistics, product configuration and international procurement instead of conventional ways of managing supply and distribution chains.

The massive change of transportation and materials handling services during the last thirty years has meant several waves of redesign within the logistics industry, including both business models and organizational principles. Traditionally transport services have been organized along the transport modes, but today the logistics service concepts address typical needs of end customers and the efficiency of the whole integrated transportation network more directly. We have witnessed the introduction of

international parcel services, intermodalism and lines of huge container ships, value added services provided by third parties, and mega carriers integrating local and regional postal and private cargo services in land, sea and air, and eventually the establishment of fully integrated international courier, business cargo and third party services. The providers as well as the customers of logistics services are hard pressed to evaluate the relative efficiency of different portfolios of interlinked services when the traditional supply chains are turning into ever changing global networks. As the logistics integrators have started to build long term partnerships for the global customers based on conventional strategies of cost or differentiation advantage (Porter 1985), the markets seem to call for responsiveness and temporary advantages.

## **1.1 Some Issues in the Analysis of Transfer Services**

There are several factors which are in flux but are difficult to include in any general model of transportation efficiency. One is the shift in purchasing power and relative power of sellers and buyers (MacFarlane 2004). Early during the industrialization process there was the seller's market for the products like with T-model Ford, a mass product sold to any customer but requiring a high relationship between seller and buyer. Today there is a market with equalized power between the seller and buyer. The position of buyer is getting stronger, however, and in the near future the buyer can get by with a low relationship to the seller. The increased purchasing power means that the customer is going to dominate the supply chains and the significance of long term relationships tend to diminish.

According to the report by CEC (1993) the quantitative and qualitative trends in transport demand depend on the mobility of goods affected by socio-economic factors such as the level of consumption in different markets and by industrial factors such as the organization of production and the diversification of supply sources. There may be also constraints that impede the matching of supply to demand which may be material, such as the capacity of the networks and terminals, or technological, such as accessibility to information technology or telecommunications networks. Brehmer (1999) suggests that in transportation planning demand and supply should be linked in terms of price, time, place and type. The constraints for the defined service products and service processes



should be formulated in terms of costs (based on an acceptable cost for the carrier to deliver the service solution to the shipper), capacity (what volumes can be handled through the network at each time), and quality (standards regarding customer service quality both internal and external). Other constraints should be considered as well, for example those related to environmental data, geopolitical changes and financing possibilities or the legislation in force (CEC 1993).

As a side effect in transport chains capacity balancing problems are created. At transportation nodes, like ports and terminals, cargoes are temporarily stored for further transportation in another mode of different capacity. In manufacturing minimized in-process inventories are considered a sign of efficient operation. In transportation, however, the scale differences are biggest between such as ocean ships and trucks. The largest ships currently, rated at 8000 TEU capacity, are employed to achieve economies of scale at sea. This is revealed e.g. in a series of interviews conducted by Cullinane and Khanna (1999) with eight of the major container lines (Maersk, NYK, NOL, MOL, COSCO, P&O, Hanjin, and CSC). The most quoted reasons include aiming at a competitive advantage through economies of scale in ship size and forcing competitors to react in order to combat this advantage. Bigger alliances seem to make larger ships operationally viable. There is also an expectation of future growth in container volumes as the result of increased trade, but also due to container penetration and improvements to port infrastructure facilitating the use of bigger ships.

A reason to separate different services is the divergence of incentives of port operators and stevedoring companies from those of shipping companies. Operative efficiencies can be calculated on the basis of more mechanized cargo handling along with growing ship sizes (requiring fixed investments in given geographical locations) but at the same time customers are getting more demanding in terms of responsiveness with tendency towards smaller transportation batches.

Many trade models include transport costs or some related variables, such as distance and common borders, that are used to explain the geographical distribution of international trade flows (Kumar and Hoffmann 2002). In empirical research, however, reductions in transport costs are taken as a given exogenous trend, driven by technological advances. Obviously, that should promote trade but the realized volumes

of trade lag way behind what the standard trade models suggest (Anderson 1999). When considering only transport costs and ignoring other aspects such as connectivity, safety, security, reliability, speed, or port facilitation, many trade analysts have missed the real advances in the field of transport and their potential impact on trade growth. Most difficult to build into the models seems to have been the feedback from increased trade and growing demand influences transport costs and the supply of transport services (Kumar and Hoffmann 2002).

## **1.2 Research Problem and Objectives**

Recognizing the tremendous change taking place in the transportation sector in general, and in container shipping in particular, the research problem can be stated as follows. The understanding of the different transportation services and the associated cargo handling activities has been fragmented along the modal choices and institutional settings so that there are different route structures and speed/capacity tradeoffs for land, sea and air transportation offered within internal distribution organizations, outsourced services or public postal services. According to the introduction above, this categorization based on the production side of transport services has applied, up to the 1970ies, to the actual services used in the marketplace. Since the introduction of unitized loads, combined or intermodal transportation, and integrated courier services there has been an increasing number of alternative solutions to transport and cargo handling needs and especially for alternative networks configurations of interlinked services. In other words, there are different types of supply chains created that cater to the market demands, but it is increasingly difficult to determine if the resources for the physical transfer of goods are being utilized most efficiently. Hence it seems that despite the prevalence of integrated multimodal services in practice there are no matching theoretical models of general transfer capabilities available for the analysis of the transportation sector.

Is it possible to have a model of transfer needs – volumes of cargo to be transported with various timing, handling and delivery specifications – that could be matched with some abstract description of the transfer capabilities facilitating the supply chain without committing to a given mode of transport or organizational structure? The only requirement really is to classify and combine different elements of transfer capabilities so

as to achieve feasible and efficient solutions that satisfy the customers' goals while maintaining the economical utilization of the organization's resources (Brehmer 1999). The lack of such a model may reflect the shift in the market power from the service supplier to the sources of demand that has gone unrecognized. This has been reflected also in the limited differentiation of supply chains that do not count for the different demand conditions of the members of the chain or for the specific implementations possible with alternative transfer services. Moreover, for the matching of the demand and supply of transfer services may not be stable but has to adapt to changing market conditions. A case in point is the adoption of new technology, say cranes in a port, that call for redesign of the loading and unloading processes and organizations.

The dissertation has the following objectives:

1. Describe the relevant changes in the economic environment and logistics services in terms of the evolution of transportation and materials handling capabilities especially in container shipping.
2. Develop a normative framework for the classification and analysis of physical transfer capabilities by defining different types of transport and materials handling needs and business organizations that provide the delivery channels for the transfer services.
3. Demonstrate how the long term changes of transfer services and the associated public and market institutions can be explained by the efficient matching of different transfer capabilities with new types of channel organizations, including technological and organizational innovations in container shipping.
4. Analyze the impact of the material handling in ports to the performance of container shipping services and describe the redesign of the organizational and technological interfaces.

The dissertation is targeting for novel approaches in the development of capabilities and service solutions in container shipping industry. Simultaneously it is meant to be a retrospective cross-section of developments in container shipping – without suggesting that there is straight development lines from past to the future. The ultimate target in the research initiatives however is to find such generalized principles for strategic level structures and efficient operation, that they could be applied over the entire physical

transfer chain to support the development of solutions in conceptual and operational level. In order to facilitate this, the dissertation should provide concrete information conducted from experiences and examples in container shipping to support the decision making in the logistics industry - service providers in shipping, transportation, stevedoring and logistics services, their customers - shippers and consignees and the authorities for defining the operational alterations, allocation of resources, and directing the further research efforts. Another target is to increase understanding of the forces involved in transfer chains and thus to create a more holistic view of the challenges. Due to these targets the investigation is throughout the dissertation reflected against the development of the global economy, technology and supply chain management issues where appropriate.

The new framework is used to examine and analyze concepts and practical cases in container shipping. Container shipping is used as a test environment where technological and organizational solutions are applied or could be applied in practice for efficiency improvements. The applicability of the framework is not tested in other settings in the dissertation. The investigation involves in addition to sea transportation and port operations also the land transportation phases and terminal handling in the container transportation chain. Thorough analyses require that besides so to say more structural questions additionally several closely linked themes are to be investigated. Therefore issues like integration and connectivity between the parties involved in transfer chains are investigated in several levels. Advanced solutions and operational practices are searched by examining the organizational models with strong emphasis on the role of standardization and technologies (cargo handling, transportation and information technology). The influence of economic development trends and globalization to transfer services is reviewed. One target of this dissertation is to enlighten the significance of inventions, turning them into innovations and discuss how they are adapted into practices within the industry.

### **1.3 Methodological Issues and Research Methods Used**

Logistics and supply chain management (SCM) cover a wide range of functions and issues of the corporate business and operations. Transportation and cargo handling issues are considered as parts of logistics whereas SCM is often seen as a wider concept. We see a need for a rather holistic view for both the theoretical treatment but especially when examining the more practical development challenges.

#### **1.3.1 Approaches in Logistics and Supply Chain Management Research**

Kent and Flint (1997) see that logistics has done an outstanding job of developing specific solutions for specific problems. Now according to them there is great opportunity to bring marketing, engineering, operations management and logistics closer together. In interviews, logistics experts claim that integration of logistics has been seen as key differentiator for firm, through strategic concepts such as integrated supply-chain management, logistics channel management, interorganizational efficiency, environmental logistics, reverse logistics, globalization and information technology (Kent and Flint 1997). The next era was anticipated to address integrated supply chain management and the associated behavioral and boundary spanning issues, such as customer perceptions of a firm's logistics systems, cross-functional behaviors and use of multiple channels. In the future, with the boundaries partially disappear it is required to understand all components of the supply chain. Blending services and logistics as a means of differentiation is seen as a viable direction for strategy. Kent and Flint (1997) also see theory building as future focus as it concerns sound empirical examination of construct relationships over multiple industries and situations, a view well accepted in this thesis as a link between the theory building and the practical expectations.

They also see logistics development as evolutionary by nature and events in the macro environment involving many dimensions of business and society drive changes. Therefore according to them such issues as technology, shifting business needs, cross-fertilization of disciplines, new research findings, and many others contribute to the evolutionary

process. Unforeseeable incidents however are happening and discontinuous developments going on in several branches of societies. Technological development for example may be non-linear and have unexpected and discontinuous, revolutionary consequences. While the classic strategic method can be seen as application of the past to the future, and coming up with a single, likeliest story of how things will turn out, one can also start with multiple scenarios and apply the future to the present (Bobbitt 2003). This thesis uses both methods; quantitative and technical information is used as well as more qualitative and dynamic data typical to scenario planning. Furthermore, Mentzer and Kahn (1995) claim that logistics research has been influenced by the economic and, to a lesser degree, the behavioral approaches. Hence cost minimization and profit maximization using mathematical modeling, simulation, and sensitivity analyses has dominated the psychological and sociological descriptions obtained via questionnaires, interviews, and case studies. The approach in this dissertation is partly economic as cost analyses, mathematical modeling, simulation, and sensitivity analysis are used in order to find profit maximizing solutions. The most central part of the work is cost-based theoretical modeling and the application of that. However behavioral approach is also used in terms of case analyses and use of the practical experiences of the author in the industry. Also questionnaires are used for collection of information as well as interviews in a limited scale. Most importantly the behavioral approach is a lot related to the author's view of the value of these issues in the future development of supply chains. People (or human resources) are still in an important role in service industry. The experience of the author is that the efforts of individual persons may end up in significant consequences. This is closer to the picture of human in the interpretive research tradition with proactive and voluntaristic people rather than positivism that according to Mentzer and Kahn (1995) consider people deterministic and reactive.

The development of the framework has been an iterative process between inductive and deductive approaches where it has been difficult to keep account on the chronological or even logical sequence in which the alternative framework structures have appeared. The reason for this is maybe that, first there was too many individual issues having influence on the particular research challenge, and second it was possibly not clearly visible enough in the beginning how to simplify the research question and to pick up the most relevant elements out of the multitude available. As a consequence a variety of approaches were

used although the transaction cost theory remaining as a basis, and hence the research may be called adaptive (Hilmola et al. 2005). Another perspective is related to the availability of tools in a given moment of time. The framework - Transfer Service Matrix - turned during the work into methodology that was first tested but also utilized for analyses. The most of the case examples from the operational logistics environment had been analyzed during the earlier research already, however after having the new framework developed the same cases, if not appeared in a completely different light but certainly created new thoughts of the allocation of future development efforts related to the challenges faced in the cases.

The complicated research target in hand has been approached as versatile handling as possible - at the same time as individual operational improvements are investigated, a more holistic view is aimed to maintain. The central approach of the Theory of Constraints (TOC) introduced by Eliyahu M. (Goldratt and Cox 1986) of looking organizations (and here groups of organizations) as systems instead of simply processes, is generally found familiar. The idea that system's performance is dependent on the weakest link (constraint) is applied in the analyses of port operations as part of chains or networks. The scientific approach in this dissertation is neither purely positivistic nor interpretive - according to Mentzer and Kahn (1995) the likely contrasting approaches in logistics research - but both of these approaches are used. Positivism according to them has the goal to explain and predict reality, where reality is considered to be objective, tangible, and fragmentable. In principle this fits well with the topic of this dissertation where physical transfer of goods is investigated. It is also in line with the author's view that all individual elements involved in supply chain must perform well and the operational efficiency has an important role in the successful every day business. However the interpretive scientific approach which according to Mentzer and Kahn (1995) portrays reality as a collective of multiple socially constructed realities with time-specific and contextual research findings is more likely the approach when compatibility between organizations in transfer chains of different conditions or adapting networks in supply chain management are discussed.

As a conclusion the author sees himself interactive and cooperative in the research issues - interpretive researcher, that is willing to understand the phenomenon in question

(interpretivism), the forces influencing in that, but also explain and partly predict reality (positivism) although prefers to outline future development paths, typical to scenario planning. This is only partly in line with the findings of the investigation by Mentzer and Kahn (1995) where they suggest that “logistics researchers need to undertake more hypothesis testing studies to develop the logistics theory base, need to use other types of methodologies for greater breadth to the discipline and employ more rigorous methodologies for improving sensitivity in detecting findings.”

### **1.3.2 The Applying of the Methodologies in the Dissertation**

The framework developed by Mentzer and Kahn (1995) for formal hypothesis formation, construct definition and measurement, and testing, offers a comprehensive perspective on the logistics research process. Basically the research in this dissertation - as the main thread behind - followed their framework. However the constructive research method (Kasanen et al. 1993) is better to describe development process of the Transfer Service Matrix. It is definitely a managerial construction - a lot similar to what Kasanen et al. (1993) use as an example what in management accounting a new budgeting system or a new method of supporting capital budgeting is. As they address intuitively it is relatively clear what is meant by the constructive research approach: Managerial problem solving through the construction of models, diagrams, plans, organizations, etc. Besides the construction of the framework the dissertation entity however is offering a wider set of approaches to the dissertation topic. This work have both supporting the development of the Transfer Service Matrix and offered test benches for it, and also partly lived a separate life not that rigorously following the framework template by Mentzer and Kahn.

Out of the different literature review types, the integrative literature review has dominated in this dissertation. Literature has been used for formulating a research agenda with a set of research propositions, however also a variety of observations have been made besides during the idea generation phase. The substantive justification is therefore searched from both of the sources in order to formulate the research problem and establish the main research questions. Additional research questions are detected and formulated during the advancing of the research process.



The dissertation first deals with approaches to structural issues followed by questions involved in strategic decision making of corporations. After creating the big picture the dissertation advances towards more detailed and container shipping industry specific investigations. These include reviews from the past trends ending up in investigation of practical solutions and operational applications of the framework created.

The central element of research goals of the dissertation is a creation of a framework for the analysis of physical transfer services. It also later serves as methodology used throughout the dissertation. The approach in this study is pragmatic as the target setting is strongly influenced by managerial point of view. Therefore theory building itself is pushed on the background although theories are applied throughout the dissertation. The theoretical basis of the Transfer Service Matrix is in the transaction cost economics that was introduced as such by Williamson (1985) - although several predecessors have contributed to the theories it is based on. A somewhat positivistic approach is used in this one of the central parts of the dissertation. As Vafidis (2003) conclude transaction cost theory is a fairly positivistic economics theory, assuming that the economic relations between two parties follow predictable patterns, resulting in attempts to optimise the economic benefits for each party in the relationship. Basically in many aspects presented in the dissertation could have taken the point of view of transaction costs theory. The limitations of the theory however are manifold as discussed also by Williamson (1985). Some similar limitations (like measurement difficulties) can be seen in the Transfer Service Matrix. On the other hand transaction cost theory for example regards companies more as governance structure (although mostly applied in production environments) than production functions, it assumes production assets are specific to certain types of production (not necessarily the case e.g. in networked service production), it typically leads to partial models and also doesn't e.g. easily stretch to cover multiple simultaneous relationships or organizations (like in networks) at the same time. Therefore it is not much applied in the formulation of related elements of the Transfer Service Matrix (especially transfer channel) as target was a relatively comprehensive framework. This new framework developed for transfer services is of matrix type set by two axes and is similar to what Hayes and Wheelwright (1979) presented for the analysis of manufacturing. The development of the framework for physical transfer services is presented in stages and argued in this thesis. The

development was based on the constructive research approach (Kasanen et al. 1993) that may be characterized by dividing the research process into phases, during which a solution idea is constructed, it is demonstrated to work so as to contribute in a given theoretical connection, and the scope of applicability of the solution is examined.

The Transfer Service Matrix has been used for the positioning of transfer services relative to its two axes and to what is believed to be the efficient diagonal of the framework it is used for presenting the past developments of transfer services and for out-lining the future developments. Although the Transfer Service Matrix is intended for higher level analysis, in the thesis it is used for the case analyses of some technological and organizational developments within the physical transfer services of container transportation chains even in a level of individual technological solutions.

Hypotheses as such are not formulated in the thesis and therefore not tested either, but the most effort is put to test and validate the Transfer Service Matrix developed. On the other hand some of the hypotheses of alternative future development paths that are widely discussed in public and presented in the literature are tested in the Transfer Service Matrix. One of the challenges in creating matrix frameworks in general is that the axes are not orthogonal to each other. Related to that another risk to be avoided is that the resulting solutions in matrix area (e.g. the generic solutions) are to be asymmetrically dependent more to either of the two axes (like is more or less the case with Hayes and Wheelwright matrix frameworks). These pitfalls are especially tried to be avoided in during framework development process.

Although the argumentation in the Transfer Service Matrix is based on both the absolute costs and transaction volumes, and what is more relevant to the relative share of variable and fixed costs, the formal mathematical argumentation with exact case solution specific cost information is left to be done in the future research.

Research and studies concerning especially the more ‘soft issues’ like behavior in organizations are not so easily found in the logistics literature or related to supply chain management research. Therefore it has been a necessity to acquire this kind of qualitative data from the researcher’s own experiences as a former practitioner. These experiences are also closely related to the case studies conducted in this dissertation. According to

Yin (2003) the case study method is appropriate when investigators either desire or are forced by circumstances (a) to define research topics broadly and not narrowly, (b) to cover contextual or complex multivariate conditions and not just isolated variables, and (c) to rely on multiple and not singular sources of evidence. The latter two have been the dominating reasons for use of case study method in this dissertation. Further according to Yin (1994) in a case study a contemporary phenomenon is investigated in real-life context where the boundaries between phenomenon and context are not clearly evident. Case studies can be used to provide descriptions of the phenomena, to test existing theories or to generate new theories. Case studies have been used in this dissertation for the first two of these purposes. This study is of a multiple case study type as several different cases – preferably from shipping and port operations – are examined. Additionally the case study type is partly exploratory for in one of the case studies “...fieldwork and data collection are undertaken prior to the final definition of study questions and hypotheses” and partly explanatory where “...study presents data bearing on cause-effect relationships - explaining how events happened” Yin (2003). Yin (2003) also states that depending upon the situation, case studies may be conducted alone or in combination with other methods, as all have complementary strengths and weaknesses. This may ease the acceptance of arguments and generalizations that otherwise suffer from the small set of case companies (Hilmola et al. 2005).

The opportunities and obstacles for realignment are studied in port operations with a special emphasis on the interfaces along and across technological and organizational processes. This has been illustrated in two specific cases where the operational efficiency and the returns of technological investments are analyzed with formal models. An analytical model demonstrates the economic tradeoffs between the investments in cargo handling and ship propulsion technologies and the roundtrip frequency and profit potential for the shipping company. The same economic tradeoffs is approached with numerical modeling and also cost information of real world shipping operation with estimated earning potential has been used for profitability comparison calculation of some case examples. Simulation method was used in the analysis of port operations in the interface of the ship-to-shore operations and background handling. The results have been briefly reported in this dissertation. Based on the simulations the roles of the port operator and stevedoring company in establishing efficient priority rules for the process

were investigated. This included consideration of buffering alternatives on the ship-to-shore crane backreach for the elimination of demand fluctuation disturbances. In addition to that all the case examples are analyzed using the Transfer Service Matrix.

According to Mentzer and Kahn (1995) in order to assure both the individual research and the research community of the acceptability of study findings, the researcher should examine and discuss issues of validity, reliability, and precision. What comes to the Transfer Service Matrix validity – concerning the internal validity the historical effects (results that are affected by external events happening over time) are the most likely cause to potential re-evaluation required in the Transfer Service Matrix. This may be caused by a general development of technology for example or on the other hand the explosion of physical transfer transaction volumes. However this potential problem should be possible to be corrected simply by recalibrating the position of the so called efficient diagonal in relation to the axes. Construct validity concerns whether the measures assess what they purport to assess (Mentzer and Kahn 1995). The construct validity is tested in two Master's theses with real life data and business concepts in express courier and truck transportation services (Rantakokko 2003) and in sea transportation services (Kyllönen 2004). Although the Transfer Service Matrix proved to be challenging to use the results were accepted by the practitioners of the case companies. As these case companies in question represent different areas of physical transfer services (adding the case analyses of this dissertation concerning preferably port operation) the external validity is likely to be tested in a limited scale as well.

External validity applying to the rest of the results of the dissertation supposedly is not a valid problem as nothing certain is claimed about the future. In the dissertation only alternative (even simultaneous) development trends, or scenarios to be more exact, are presented based on different development powers potentially having influence on the background. Like in scenario planning (Bobbitt 2003) the results are addressed in the form where certain kind of change may have the certain likely consequences.

The reliability of the Transfer Service Matrix can be questioned. As mentioned the utilization of the Transfer Service Matrix has proved to be challenging. The reliability is defined as a measure's ability to repeatedly yield similar results across similar situations (Mentzer and Kahn 1995) therefore a potential problem is created as it is not possible to

ensure that the Transfer Service Matrix is repeatedly used the same way. The problem is more related to the precision - that addresses the sharpness or exactness of observations measured (Mentzer and Kahn 1995) - of the Transfer Service Matrix. The users of the Transfer Service Matrix have been able to roughly position the services for analyses in the framework, but have been in problems in fine-tuning. The matrix should possibly be more self-explanatory and more clearly defined in order to avoid these problems.

## **1.4 The Organization of the Thesis**

This thesis consists of eight chapters. The first chapter is an introduction to the thesis with general trends in transportation sector in order to motivate the study. Further the research problem and objectives followed by the research methods and research process used are presented.

The purpose of the second chapter is to give an overview of the theoretical basis of demand and supply of transfer services and their dynamics, the structural issues involved in and the variable aspects in innovation and construction of transportation and transfer chains. The topics have been approached with a literature review. The topics include the external factors and forces of change in transfer chains but also their influence is discussed here. Some relevant compatibility challenges in transfer chains have been discussed here as well.

The third chapter introduces the Transfer Service Matrix (TSM) developed in the research. It is later argued and tested, and used for various analyses throughout the thesis. The related theoretical approaches in the literature, some supporting phenomena from practice, and analyses of transportation sector are included in the chapter.

In the fourth chapter the developments and innovations of container shipping industry are connected to the experienced general development in physical distribution, container shipping with its characteristics is introduced, and the future prospects of container shipping are outlined.

The fifth chapter addresses the compatibility of capacities between transfer phases in container shipping, the influence of cruising speed of ship vs. cargo handling speed, and the efficiency achieved with alternative technology investments. The research challenge is

approach from the shipping company point of view. An advanced technology concept is introduced in a case analysis.

In the sixth chapter the role of port operations in container shipping is discussed in more detail with real life challenges and developments needs. The research challenge has been handled from the port operator/ stevedoring point of view. Two case analyses for increasing efficiency in port work are presented – one for organizing the ship cargo handling and one for technological solution of the same. Through the cases also some compatibility issues are discussed in terms of real life experiences.

The results are presented and discussion of the research findings takes place in the seventh chapter. In the eighth and last chapter the findings of the thesis are concluded. The managerial implications are discussed and the needs and topics of future research are also briefly outlined in this chapter.

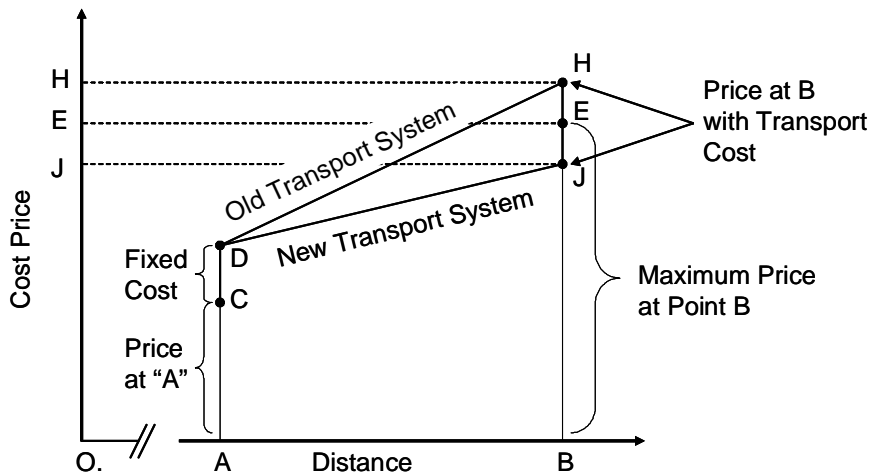
## **2 Structural Analyses of Transfer Capabilities**

Regulation and structure has dominated the transportation industry. Transportation sector - especially when sea transportation is concerned - differs from most other services due to the heavy investments are required. Investments made in ports, terminals, channels etc. are geographically fixed and may increase the business risks for operators, and reduce the companies' ability to move to more attractive areas. The investments create entry barriers for newcomers, but at the same time prevent changes within the company. The competition may have limited due to exclusive rights given to e.g. communal companies or similar organizations. In the maritime transportation for example the incentives of port operators and stevedoring companies are typically different from the incentives of shipping companies and shippers. Thus the existing structures slow down the front march of more efficient organizations and operative solutions. At the same time the surrounding world has changed to require quicker reactions, shorter delivery times and smaller transportation batches. Such a complicated and yet rigid system is to be changed towards a more market driven business. Lately the structural dynamic has been increasing also in Europe due to deregulation and new market areas - e.g. the expansion of European Union to include the former Eastern Europe. Legal barriers to market entry are tried to be pushed into the background (although there is still significant barriers for international trade) and increasingly substituted by economic factors. In global scale countries like China and India are increasingly consuming raw materials, gaining strong position in manufacturing and service production, and begin to be positioned as significant players in the global economy with potentially huge markets for end products.

### **2.1 Leverage of Transportation**

As fundamental part of the economy and trade, according to Coyle et al. (1994) transportation systems help determining the economic value of products. In Figure 2-1 is shown a case of transfer of a commodity produced at point A to point B where the commodity is desired. First with the old transport system the transfer is not feasible for the total price at point B – sum of the price at A, and the fixed (CD) and the variable

costs (DH) of transport – exceeds the maximum price the customer is prepared to pay. If the transport system is improved so that the cost per mile or slope is reduced resulting in variable cost (DJ) leading to a total price at B which is less than the maximum price of the customer at B. The market for the commodity would be expanded to cover customers in point B, while production continues at A.



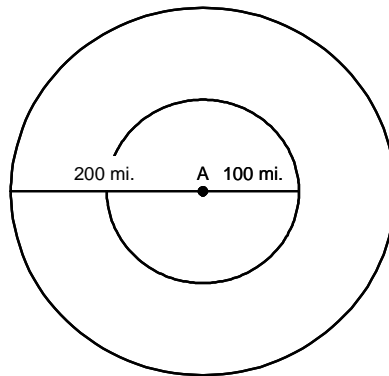
**Figure 2-1** Landed Cost with Old and New Transport System (Coyle et al. 1994)

In the latter situation the commodity has gained what Coyle et al. (1994) call place utility. The more efficient method of transport created utility - the goods have value at point B - compared to with the previous method where the goods had no value for they would not be sold at the market.

Reduction in transport costs encourages customers to purchase products from distant suppliers that might otherwise be produced locally. The reduction in transportation costs is actually relatively much greater for long distances because of the decreasing share of fixed charges also an increase in the feasible distance will increase the market area of the product in an even greater ratio. The latter phenomenon called by Dionysius Lardner as the law of Squares in Transportation and Trade tells that the relevant market area increases four times in size when the radius is doubled. This is illustrated in Figure 2-2, where a producer at A can afford to transport 100 miles and meet competitive laid-down costs. The circumference of the smaller circle shows the boundary of the relevant market



area. If transportation cost is cut in half, the same sum will now transport the supplier goods for twice the distance, 200 miles (Coyle et al. 1994).



**Figure 2-2** Lardner's Relevant Areas (Coyle et al. 1994)

It is common that demand for a particular commodity only exist during certain periods of time - if a product is at a market without demand, it has no value. Time utility is created by efficient transportation by ensuring that products are at the proper locations when needed. Speed of transportation may be a governing factor for the transportation of e.g. some perishable products with limited shelf life. Lardner's Law means that if the smaller circle represents the current market area based on a specific transportation speed and the speed is doubled, the potential service area would quadruple (Coyle et al. 1994).

## 2.2 Demand and Supply of Transportation and Related Services

There are long-term cycles in the demand of international freight transport services. This tendency of peaks and troughs in the demand is a reflection of fluctuations in the demand for commodities (Button 1982). Therefore the international transportation volumes are linked to the general activity in the world economy and the geographical division of the cargo flows is dependent on the regional trade outlooks. Functioning service supply however may also promote business activity in the region. In addition to the macro-economic cycles the service needs vary according to the season of the year and e.g. in ports in addition depending on the day of the week and even time of the day (due to economic factors like extra fees charged during weekends or night hours).

In the literature of services, transfer services (transportation and cargo handling) are typically not analyzed separately. Also where these services are analyzed, the physical character of transfer services has been given little emphasis. The traditional division between goods and services production is too rough for transfer services have properties of both of these. Increasing commoditization of processes (Davenport 2005) lead to conceptualized transfer services with similarities to mass produced goods. Their production mechanism is a lot factory like although not necessarily tied in to a certain geographical position. Unlike traditional services, most physical transfer services are not produced in the interaction between buyer and seller but separate. Many times the services are produced on the other side of the world where the customers cannot participate in the production. Like a goods production process sometimes run idle also the service production process may produce service despite of it is not utilized - in liner shipping ships are leaving even half empty according to the schedule. Therefore it would be misleading to say that the production, distribution and consumption are simultaneous processes as this service is produced and distributed but not consumed in time. Similar waste is in goods production if perishable good is produced and distributed but not consumed in time. Also a common division of service from physical goods is that they cannot be stored. In transfer services however it is possible to move goods closer to final destination e.g. to a port terminal in the target market. Thus also transfer service is stored as it would be difficult to otherwise explain the value added. Finally in order to facilitate the supply of transfer services, capability needs to be constructed. Capability here is similar to what is required of production systems in goods production. Brehmer (1999) gives capabilities the following definition: An organization's capabilities are the result of how skills, technologies, supplier/customer relationships, human resources, and other resources have been integrated to create a foundation to serve the customer.

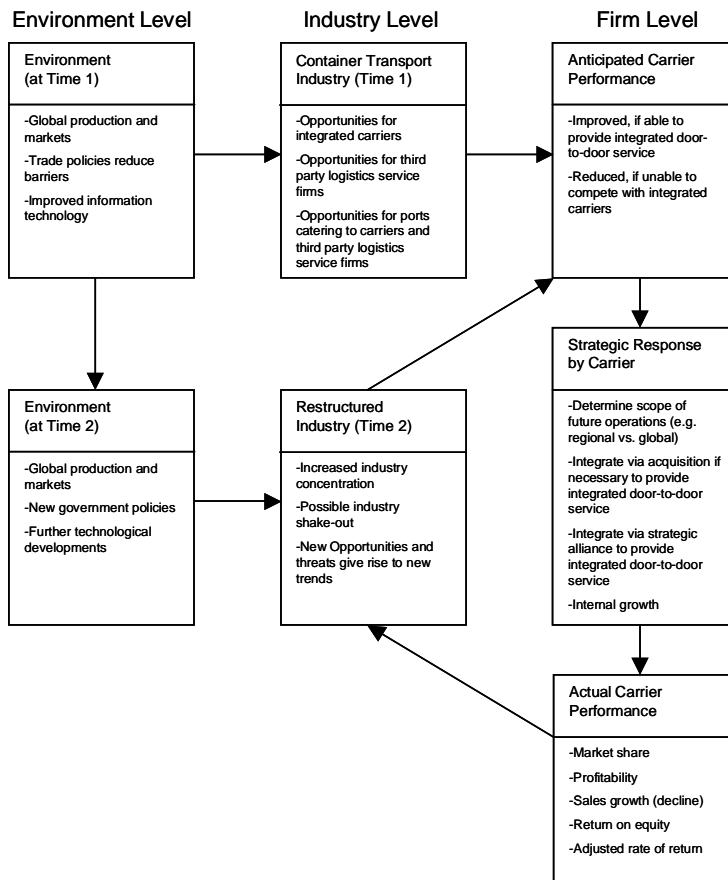
The service supply side is stiffer than the demand side for infrastructure investments, mechanical technology in transport and cargo handling besides the manual work is required to move the physical goods. Depending on the transportation service and transportation phase in question the significance of physical structure varies. Many parts of the transportation system - e.g. ships, trucks - are mobile and can be re-allocated. Some of them however, such as ports and terminals with some of the superstructure, are geographically fixed. Within a couple of year's perspective this doesn't create problems

for normally the changes in service demand are relatively slow and small. Thus there are good opportunities for planning, but due to the scale and long life-cycle of the investments in question, the absolute economic risks in false decision-making tend to grow. The significant variances typical to short-term cycles are more difficult to adapt. Therefore capacity may remain idle whereas somewhere else the services are fully utilized or is suffered from lack of capacity. The capacities are not balanced internally neither within the transportation chain between the different parts of it. To cope with this feature, transportation chains are mostly asynchronous (operation where dependent activities are de-coupled from each other) and buffer stores are used to adapt the imbalances. This can be seen e.g. in ports where the big cargo volumes of ships are switched to another transportation mode of smaller carrying capacity. In practice storage facilities are needed at the port for the freight is held until sufficient volume is obtained for efficient handling by barge or ship. Conversely, when a loaded vessel arrives at port, the freight is unloaded, stored, and then dispatched in hundreds of rail cars or trucks at some later date (Coyle et al. 1990). In principle if the capacity of land transportation fleet available according to the ship schedules is be equal to the cargo volume carried by the ship, the delivery of the containers to/from the ship could be arranged without delay.

At the same time different transportation modes are combined to transfer chains, they are in competition with each other. Compared to some other modes land transportation has in many cases competitive advantage due to denser network, higher speed in deliveries and flexibility to move smaller batches. Pricing policies also guide the operations and may even distort the relative competition situation between the modes. The attraction of land transportation increases if the navigation, pilot and port costs are high, thus creating economical barriers to the ship to call many ports. This takes place e.g. in short-sea traffic where sea transportation services (or inland water transportation) are in competition with truck or rail road transport. It is common however that the overloaded land connections (e.g. in the Middle Europe) make it difficult to utilize the economies of scale in a full potential measure. Easier could be to manage cargo transported through smaller port closer to the final destination. Especially self loading /unloading vessels can utilize their higher built-in flexibility in such situations.

## 2.3 External Factors and Forces of Change

According to Brooks et al. (1993) in any event, the subsequent performance of the firm, or its competitors, all interact with industry and environmental forces to shape the industry. That environment and the driving forces at work in it are detailed in the model – the example again taken from the container transport industry - in Figure 2-3.



**Figure 2-3** A Model of Strategic Behavior in the Container Transport Industry (Brooks et al. 1993)

The model has hierarchy structure defining the different levels influencing the behavior in the industry. Although the strongest steering forces come from the environment level it is

evident (see the previous paragraph and above figure) that there is a loop of continuous interaction between the industry level and company level developments.

The competition (anti-trust) regulation and merger policies of governments are used in order to control the companies' strategic choices in shaping the industry structure. The development in Europe however has left most EU countries with only a few major liner carriers. Another issue is that the increased competition on a global scale is forcing firms to consider greater integration of their production processes with suppliers and markets. This is further accelerated (like in container shipping industry) by technological developments whereas organizational approaches have increased the co-operation between companies for example in different kinds of joint initiatives.

### **2.3.1 Geographical Specialization and Globalization**

According to Coyle et al. (1994) the concept of geographic specialization assumes that each nation, state, or city produces products and services for which its capital, labor, and raw material are best suited. Also as any one area can't produce all needed goods, transportation is needed to send the goods most efficiently produced at point A to point B in return for different goods efficiently produced at point B. The concept is aligned to the principle of comparative advantage; it assumes that an area specializes in the production of goods for which it has the greatest advantage, or the least disadvantage (Coyle et al. 1994). It is also behind globalization - goods are produced in location that offers the highest cost advantage to the total costs in the value chain. According to Haapanen and Vepsäläinen (1999) this means a dual change where: 1) the end customers require more tight connection to the timeliness instead of geographical location 2) the production of labor-intensive branches is located in developing countries with low labor costs and the highly automated production to industrialized countries.

Russell and Taylor III (1998) claim that world-class companies have achieved their status by recognizing the strategic importance of operations and adapting operating systems to changes in the environments. Further this is especially important today as continuing advances in information technology have increased competition and together with changing political and economic conditions, have prompted an era of industrial globalization in which companies compete worldwide for both market access and

production resources. They state that companies “go global” to take advantage of favorable costs (usually labor rates) in foreign countries and to access markets. They continue however that according to studies many U.S. companies are more interested in accessing new customers, technologies, or skills, rather than capitalizing on cheap labor. Falling trade barriers and changing markets fuel the globalization trend and global companies produce and sell around the world. However in certain countries stability of the governments and poor economic conditions continue to inhibit increased trade and localized operations. They state that rapid economic growth in Asia has stretched its transportation infrastructure to the limit where bottlenecks in ports, road, and rail, are delaying products from reaching their market. Also the markets themselves are highly fragmented with distinct languages, customs, trade barriers, and levels of development. Finally the distribution channels within regions are unorganized and inefficient.

Transportation is required to offer advantages where geographic specialization is complemented by large-scale production, but also to increased competition for local producers for the benefit of consumers. Without the use of effective and efficient transportation networks, the advantages of scale economies, production efficiencies, and cheaper manufacturing facilities would be destroyed (Coyle et al. 1994). In order to satisfy the transfer needs different services is required in different circumstances as before. However together with the advancing globalization the international transfer transaction volumes are growing and more harmonized service needs may appear giving growing space also for conceptualized services with attractive pricing for the customers. On the other hand the global demand (partly in contradiction to the development in production) requires extensive geographical presence and availability of the service.

### **2.3.2 Technology and Physical Structure**

According to Haapanen and Vepsäläinen (1999) development of transportation networks and frequency of transportation connections have enabled the international distribution of goods, components and raw materials. The transportation alternatives provide more flexible operation models than was possible previously - the transferring of goods is not any more a problem although may be a significant expense. Some of the advanced transportation systems have increased efficiency and cut the expenses significantly.

Containerization is an example of technology where port cargo handling productivity increased multiple tenfold and the expenses were reduced respectively. Also the cost structure has changed - the relative share of fixed cost elements have increased whereas the variable cost part has decreased. The technological development has reduced the need for manual work, therefore transportation industry has transformed from a labor intensive towards more capital intensive industry. The developing technology will probably be in an important role to influence the transportation costs and cost structure also in the future. The more significant technological innovations – if any revolutions in transportation sector are to be expected – will probably be related to applications in information and communication technology however gradual development will probably take place also in the transportation equipment and physical cargo handling.

In the literature services are classified as low entry barrier industry with low investments required. In transportation service industry this apply partly to services like land transportation that according to Yamada (1990) is governed by the logic of human costs. However in the literature of shipping topics, in shipping management capital logic is the most important factor (Yamada 1990). Concerning container shipping (e.g. Muller 1989, Oda 1991) the large capital investments required in the containerships, containers, container handling capacity, and terminals required for the container shipping operation is clearly addressed. Containers cannot move without costly handling gear and stop moving where no such gear is available. Sea transportation systems are supported by large capital investments in transportation infrastructure, land area, ports and terminals, cargo handling equipment, ship fleet, transportation units and marketing channels and organizations. Shore investments, berths and handling equipment, can prove very costly, particularly if a purpose-built vessel requiring capital-intensive transshipment facilities is to call at several ports (Branch 1982).

The physical prerequisites for transportation activities are based on infra- and superstructure. Infrastructure is typically owned by public sector, whereas superstructure is owned by private companies. Concerning port sector the European Community has released a more fine expression where the port infrastructure has been divided into three groups (Navigator 1993): 1. Channel and safety infrastructure - responsibility and costs carried by public sector, 2. Port infrastructure (e.g. quay, terminal) - responsibility

carried by public sector and costs paid by the user and 3. Port superstructure (equipment etc.) - responsibility and costs carried by the operating companies.

Also in the transportation sector the investments made should be efficiently utilized and reasonable return on investments is required. Inefficiency in one part of the chain may cause extra costs to the other parties thus reducing their competitiveness. The efficient utilization of capital is getting more important due to the fact that technical change in transportation is labor saving and capital using. It is shown that the rate of growth of total factor productivity for example in ports has been mainly the result of technical change and, to a lesser extent, economies of scale. Strong productivity in ports is particularly important since port services are used by almost every sector of the economy and particularly so in small economies (Kim and Sachish 1986). Operative high productivity could mean that the material flow is piercing the supply chain quickly and without stops (capital is tied also into the goods) but at the same time with low costs and minimum idle time for the equipment.

The development of intermodalism and inventory control with smaller transportation batches shapes the structures to what is seen in manufacturing with JIT production systems. These kinds of structures require uniform cargo flows. The closer to JIT production the slower it is to react to rapid changes in market situation. According to Ojala (1991) arranging the port facilities for peak demand is more problematic than organizing manual work. Investment decisions may prove unfortunate with an equally long economic life for the misplaced investments and may hamper future investment with notable better trade-offs (Ojala 1991). Typically the type and size of investments in the transportation systems have close relation to the planning horizon and therefore the refund and life times of them may also vary significantly accordingly. Normally the bigger the investment the longer is the expected lifetime of it; for example smaller cargo ship 20 M\$ and 20 years, truck 0,2 M\$ and 5 years. Likewise infrastructures investments tend to be more permanent than investments in technology and superstructure.

Investment decisions are always subject to some amount of risk. The uncertainties in forecasting the future circumstances are increased when the time scales expand. Big investments typically required in parts of transportation sector tend to create rigid physical structures. This may e.g. either force the material flows to follow certain



channels or to be a source of potential financial risks in fluctuating markets. According to (Eno 2003) shifts in global logistics networks can render a terminal or corridor economically obsolete long before the end of its physical life. As the willingness to invest is typically increased with reduced risks of loss, in a turbulent environment the investments could be smaller. In some cases risks related to geographic location can be reduced with investments into portable technologies.

Information technology investments may significantly increase the productivity, and if well managed, with reasonable risks involved. Singapore (world's busiest container hub port) for example has promoted B2B eCommerce in the logistics sector. A nation-wide EDI system *TradeNet* was introduced in 1986 (Siong et al 1995). Today the system is in Internet ([www.tradenet.gov.sg](http://www.tradenet.gov.sg)). It was set up to link traders, freight forwarders, shipping agents and government organizations for the processing of trade documents, airway bills and shipping orders. The users can access trade-related databases like flight schedules, shipping schedules, cargo information and freight tariffs. *PortNet* ([www.portnet.com](http://www.portnet.com)) migrated from EDI to Internet technology recently, is linked to major ports like Rotterdam and Seattle to facilitate trade document processing for sea cargoes. *SPECTRUM* ([www.ccn.com.sg](http://www.ccn.com.sg)) is a specialized air cargo community system developed to allow paperless cargo-related information exchange among members of the community (Tan and Gwee 2002).

### **2.3.3 (De)regulation in Transportation and Trade**

Coyle et al. (1994) states that one of the future transport trends is less economic regulation (rates, routes, services, finance) but simultaneously noneconomic regulation increases (environmental, substance abuse, safety). According to Eno (2003) EC have done much to even out the differences and to remove the barriers that have divided Europe for decades by economic and political differences and physical borders. One of the principal tasks has been to secure the free movement of goods, services, capital, and persons throughout the EU. It further states that the EU transportation policy cannot sacrifice economic growth or freedom of movement, but must make mobility systems more balanced, smarter, and environmentally friendly. A White Paper, *European Transport Policy for 2010: Time to Decide* (Commission 2001) proposes three ways to

break the link that has traditionally existed between transport growth and economic growth: Change the balance between modes, eliminate bottlenecks, and place safety and quality at the heart of transport policy. In U.S. rail and truck deregulation since 1980 and building of the Interstate Highway System are largely behind the efficiency achieved where the direct logistics costs to industry fell from 16.1 percent of GDP in 1980 to 10.1 percent in 2000. This is a major source of U.S. economic growth.

Besides the efforts within some economic market areas (EU and U.S.), many of the initiatives have also had international significance. It is fair to expect that deregulation in global trade has similar positive, activity increasing, cost cutting consequences in transportation industry which translates into increased transportation demand. On the other hand although the noneconomic regulation has positive quality, safety and environment wise consequences, it tend to somewhat increase expenses and raise new, more operationally significant barriers. This is the case with raising security worries and the required procedures e.g. in ports. Another aspect is that protectionist actions are still used in the global trade. In a situation where nations and economic market areas are in continuous struggle to remain competitive in the globalizing markets, the global trade retarding elements like customs barriers and import quotas for example are used.

As a conclusion it is likely that altogether the development is gradually removing the trade barriers, decreased expenses in trade and transportation, and creating more uniform instead of fragmented markets. The consequence being increased cargo flows within and between market areas in a global scale.

#### **2.3.4 Organizational Channels**

Transfer service solutions are typically service portfolios that are formulated of services offered by different companies and organizations. They are either directly involved in the operations in physical transfer of cargoes, or are in the supporting functions of the same. It is possible that single organizations alone but more likely several organizations together form transfer channels - set-ups of infrastructure, and organizational and technological resources - through which the particular services are supplied.

In order to provide sufficient services for ever more demanding and many times global customers, the forms the service portfolios are taking need to be changing and diversifying. Besides the technological development, organizational development is namely the other probable source influencing to the transportation costs structure in the supply side. Therefore different needs are satisfied with different service supplies. In local established services traditional organization may be satisfactory, however to satisfy the need for a product or service in the global economy with fluctuating demand patterns requires different forms of organizations. The most common actions are to either increase co-operation between or to establish networks of companies and organizations. Outsourcing, where the companies concentrate only into their core business and buy the supporting operations and services from the markets or from the network, is one manifestation of such development. The drawback of such development however - if not correctly managed - can be seen in some current transportation chains. The different or separated interests within transportation chain may lead to part optimization where ship-owners concentrate to develop the features of their ships, the stevedoring companies to develop the internal efficiency of the terminal, and port operators to persuade traffic. Therefore in the transportation sector there has been also presented opposite ideas of multimodal transport operators who control the whole transportation chain from shipper to client. Some integrated door-to-door transportation operators with strong ownership driven strategy also exist but in a minor scale.

Should the future intermodal chain in the ever-changing circumstances be one integrated entity (ownership) or possibly alliance constructed of specified service organizations linked together? Should a service company be part of the global network or can it act as an individual player in the regional (or local) market? Besides similar questions, the efficient internal demand-supply balance - in company level strategies, tactical level decisions and operative work - should be valued in order to survive or on the other hand to take advantage from temporary disturbances in the market.

## **2.4 The Influence of Development Forces and Innovations**

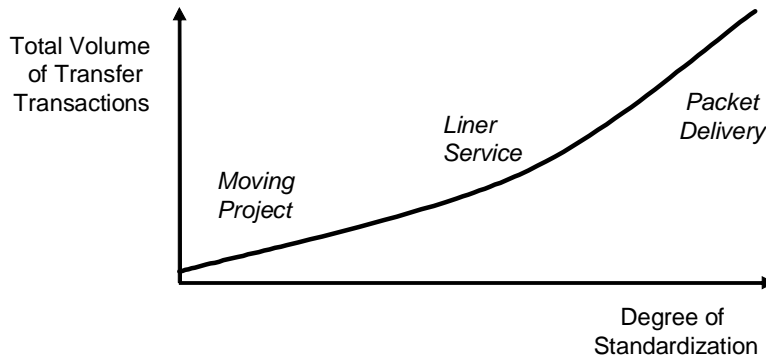
In most literature industry developments take place gradually, evolutionary innovations - or they are revolutionary by nature. According to Noori (1990) revolutionary

innovations represent major product or process breakthroughs that create a new industry or significantly change a mature industry, whereas evolutionary innovations are commonly incremental product or process improvements that occur within the firm and are necessary for its survival. Martin (1984) speaks about another category as well – innovations that result in the creative symbiosis of previously unrelated technologies. Wijnolst et al. (1993) clarify some of the terminology: *Invention* is the prospective useful idea of how science and technology can be combined or extended in a new way, *Innovation* occurs when the invention is turned into an economically successful use, and *Diffusion* is the spread of the innovation among its potential users. Noori (1990) divides the process into two partly overlapping disciplines. He proposes that the management of innovation is predominantly concerned with the creation and development of new ideas, whereas the management of technology focuses on the acquisition and application of existing innovations (the diffusion process). In this dissertation is mainly referred to the diffusion phase of the process reflected in the services provided by the service industry.

The development work is to question and change the set-up of business. This may take place in several levels (industry/company, strategy, tactical, operational), be functionally (production, sales etc.) or process oriented or motivated by reasons like increased market share, productivity, flexibility, more global presence etc. The changes tend to be supported either systematically or due to more market driven terms. The developments may be boosted by technological innovations (e.g. mobile technologies), organizational and managerial innovations (outsourcing), and changes in common values (environmental concerns) or in legislation, changes in the world economy etc. The parties in the process may be manifold; also governments catalyze development besides acting as regulation bodies. It is the individual company in the global playground however that maximizes benefits with e.g. increased efficiency and productivity, responsive production and delivery, or clever customer segmentation and so on.

Out of the four development forces discussed above, globalization, and deregulation or regulation directly influence to the demand of transfer services. The local or regional trade benefits of regulation, whereas global trade benefits of deregulation with fewer barriers. Globalization with growing trade is likely to increase the level of transfer transaction volumes in absolute figures. Further due to the increasingly harmonized

transfer needs, the already relatively high volumes of standardized types of transfer transaction (Figure 2-4) may increase even in a greater measure (typically the physical dimensions of the goods are reduced the further to right of the axis is moved).



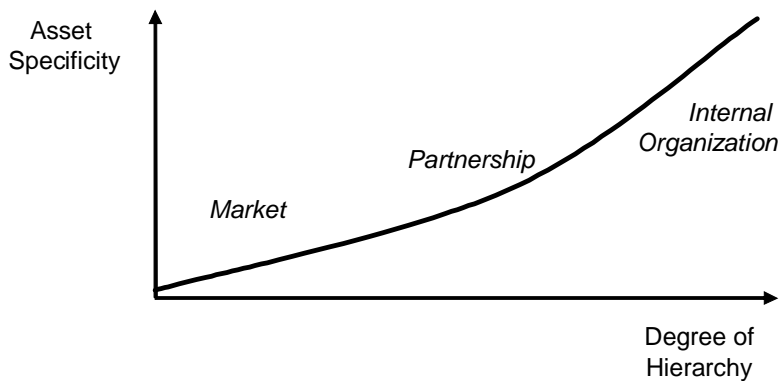
**Figure 2-4** Some Characteristics of Different Transfer Services

Brooks et al. (1993) state it is noted in the transportation literature that the trend of downward pressure on transportation rates and an increased customer orientation reduces the overall demand for ocean transport; the declining demand for bulk carriage of raw resources has not been matched, in tonnage terms, by the increase in containerized finished goods moved.

It is possible that protectionist actions with increased economic regulation begin to grow again as a consequence of undesirable changes in the atmosphere of international politics and/or commercial interests of nations and areas. This would - although could temporarily accelerate local or regional trade activity - probably restrain global trade and therefore reduce the growth in the transfer transaction volumes. The current slightly increasing noneconomic regulation is going to have similar consequences although probably in minor scale - touching different transfer service types differently.

The other two development forces, technological and organizational development with related innovations, influence the formulation of transfer governance. In order to find efficient governance Williamson (1985) match governance structures with transactions. This considers the investment characteristics (asset specificity) and frequency of the

transactions. Further he introduces the connection between the degree of hierarchy in the government structure and asset specificity - the contracting should be unified (internal organization) as asset specificity deepens. This is illustrated in Figure 2-5.



**Figure 2-5** Some Characteristics of Different Governance Structures

Integration is suggested as a source for efficiency between enterprises also by Williamson however he continues: "...where economies of scale or scope are very large would outside procurement be seriously contemplated". Integration is not likely to be the answer in large supply networks. The prospects for costs reduction are bigger in the left end of the axis for the total costs of resources involved are higher, simultaneously due to less asset specificity e.g. opportunities for resource sharing is possible. Also the technological and organizational developments are usually interlinked thus new technology besides that establish cost cutting applications may enable organizational developments that otherwise wouldn't be possible. Networks are also complex systems and therefore in better position to experience significant changes due to innovations. It is less likely that something revolutionary is invented that will simultaneously deeply change a group of different hierarchical internal organizations. The life-cycle in-built in the development of hierarchy means that as the new developments are maturing they are getting more commonplace and spread to the left along the axis. Therefore most of the innovations utilized in the right end of the axis can also be applied in the left end of the axis, but in a limited scale vice versa. Cost wise this means that also in relative the

opportunities to benefit by organizational and technological developments are bigger in less hierarchical organizations. If an innovation increases the flexibility of the systems in terms of more efficient resources allocation, the harmonized and industrialized systems benefit more. This is because of the (not specific) fixed assets represent a relatively higher proportion of the total costs of resources involved.

The development forces interact with each other. Globalization and deregulation indirectly influence the governance structures for the volumes and geographic distribution of the demand may enable more extensive geographic presence and/or due to economies of scale reduce the fixed cost elements in the service solutions. The innovations on the supply side reduce the costs, possibly risks for the customers or allow more efficient and profitable production of customer specific service, therefore the service solutions supplied are more feasible and accelerate the demand. Intermodal transport - especially container transport - gives a couple of examples of the interconnection between the development forces and the positive dynamics that may be generated to economy. According to Eno (2003) the contribution of intermodal transport to global economic integration has been characterized by three major trends:

- Quick growth in world trade - two or three times higher than growth of gross domestic product (GDP) in most countries – has been stimulated by the performance of maritime container transport.
- “Economic distances” (the cost and time of transport) no longer reflect geographic distances (geographic proximities).
- Maritime transport has structured land intermodal services in the United States as it has in Europe (for example, shuttle train services of container trains along major corridors of Europe, land bridges in the United States, dry ports inside the continents).

As a consequence of the combined effects of the current development forces, the transfer services will be more in demand. Especially services with positive influences of developments experienced simultaneously are getting relatively more attractive.

## **2.5 Configuration of Transfer Chain**

### **2.5.1 Activities of Physical Transfer Flows**

Supply chains in general are formulated of a variety of sequential (and also parallel) activities. Logistics management activities can be divided into activities concerning physical flows - relevant in this dissertation - and activities concerning information flows. Based on van Damme and van Amstel (1996) the activities concerning physical flows are:

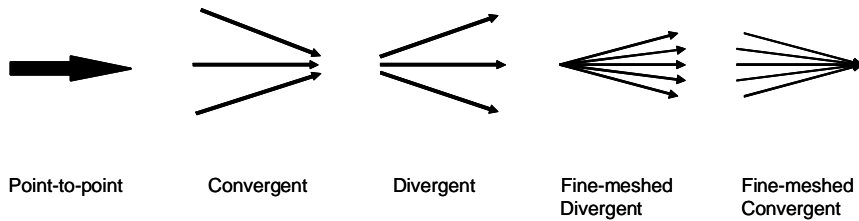
- Physical handling in receiving and unloading of goods and degrouping
- Storage control
- Internal transport
- Physical handling out including order picking, grouping, and loading
- Reconditioning and packing including (de)palletizing, (re)packing, (re)labeling, and preparing for shipment
- External transport both national and international
- Delivery
- Completion return shipments

There are similar activities concerning information flows (but these are not specifically investigated in the dissertation). They include: Order entry; Clerical handling including goods clearance, quantity check (orders, volume), quality check (packing and sell-by date or perishability); Clerical handling out including check on orders and number of order lines and preparing for shipment (forms); Creditworthiness check; Completion customs papers; Stock control; Invoicing (outgoing); Customer service (complaint resolution); and Providing management information (performance indicators).

The activities in a delivery follow each other in sequential order from phase to phase, but related information flows simultaneously in parallel to that. The product flows include a

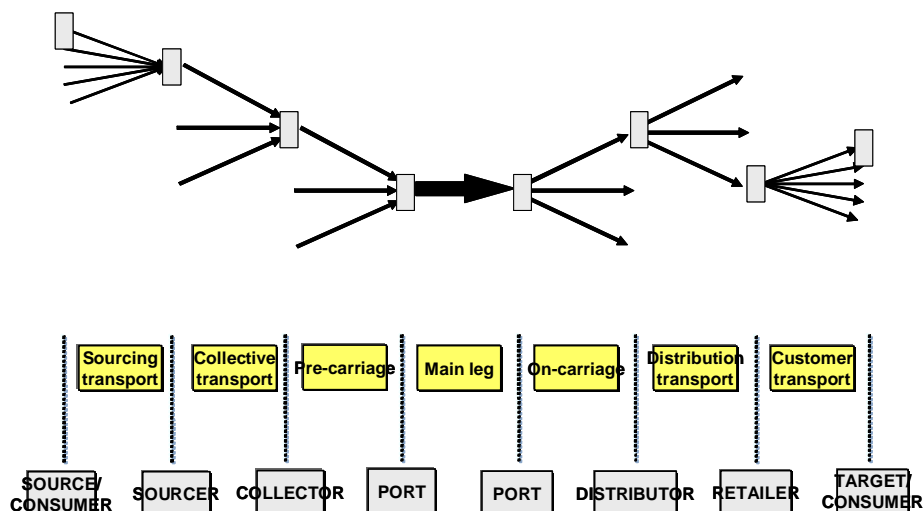


lot of parallel physical activities. As a result the product flows are either convergent or divergent, or if there is no parallel activities, point-to-point (Figure 2-6).



**Figure 2-6** Types of Physical Product Flows (modified van Damme and van Amstel 1996)

The different types of physical product flows together grouped in to sequential phases formulate transportation chain or more precisely transfer chain (cargo handling phases included) that actually connect and mediate (combine and separate) the flows. ‘Main leg’ with accumulated cargo volumes is typically considered the ‘point-to-point’ phase although this kind of distinguishing is not unambiguous but depends on the perspective chosen. The same sea leg that is considered as main leg for door-to-door transfer may also serve as a feeder link to deep-sea carriers. The preceding phases of main leg are ‘convergent’ type and the following phases ‘divergent’. The more distant phase from the main leg in question, the more likely the goods flows are narrow and fine streams (‘fine-meshed divergent’ and ‘fine-meshed convergent’) and typically more customer specific. The physical product flows and their volumes together with customer needs strongly influence the definition of the supply chain or network structure (Figure 2-7).



**Figure 2-7** The Simplified Entire Transportation Chain with Different Kinds of Product Flows, Transportation Legs, and Source and Destination Parties Involved

Depending on the customers in question - their needs and volumes to be accumulated in the product flows - transportation chain consists of a number of transportation phases. In these phases different organizations are involved and the connections between may vary from simple point-to-point connections to complicated networks. Further the structure is defined by the technological solutions in use and infrastructure available together with the geographical distribution of the investments. In this dissertation the structural issues are mostly investigated using container shipping as an example industry.

The above example chain describes the division of different kinds of product flows with the typical transportation phases for retail business. It includes the entire supply chain from raw material source to consumer. The 'customer transport' is the final - in many cases self-service, 'last-mile' - phase of transfer to consumer whereas the 'sourcing transport' may be recycling of raw materials and waste. Normally there is also manufacturing parties involved that would typically be located in a business-to-business chain in the 'sourcer' or 'collector' and 'distributor' positions respectively. There is (potentially) symmetry between the upstream and downstream parts. Actually the chain may form a cycle for consumer is in the both ends of the chain. Another related observation is that from the transfer service supplier point of view the goods flows pierce

the supply chain in two directions. This can be seen e.g. in ports where the same resource - ship-to-shore crane - moves both import and export cargoes. Typically however the transfer chains (supply chains) from the single customer delivery point of view cover only part of the entire length, e.g. in the case of semi-manufactured articles.

A significant structural element is storing. This is an elementary task for the parties in chains besides their other commercial functions. Storing - temporary and long term - accumulates the flows of cargo volumes for economical batches and economies of scale in transfer services. It is also used to eliminate disturbances in the supply chains (bullwhip effect – see e.g. Lee et al., 1997). Further like Benson et al. (1994) address it warehousing process is used to bridge the ‘time gap’ between consumer and producer for example to allow more precise and frequent scheduling for shipments and deliveries. Storing however doesn’t remove the concerns of imbalanced volumes and the capacities neither it solves the compatibility challenges faced in transfer chains (or supply chains).

There is also a multitude of other structure defining characters to consider. There are different kinds of compatibility issues especially materializing in the connection points between the transportation legs - like ports or distribution terminals. In transfer chains the activities and modes of transport, and the formulated service entities in the network should be investigated together. It is essential to find the organizational, technological, ownership and networking related, and coordination related elements that define the efficient structure and form of operation in the environment of variable customer needs, required investments and operation expenses together with the related risks.

### **2.5.2 Different Transportation Modes**

The different phases in the chain can be occupied by different modes of transportation and alternatives cargo handling technologies. The latter facilitate the change between transport equipment or modal change in the transfer chain nodes. According to their features different transportation modes are positioned in different phases of the transfer chain or networks. According to Brooks (2002) in some measure the choice of transport mode for manufactured goods is dictated by shipment characteristics – for example the value to weight ratio, the value to volume ratio and the size of the shipment. Coyle et al. (1996) present a more general ranking for different transportation modes in Table 2-1.

**Table 2-1**      Ranking of Transportation Modes (Coyle et al. 1996)

<b>Selection Determinants</b>	<b>Rail</b>	<b>Truck</b>	<b>Water</b>	<b>Air</b>
<b>Cost</b>	2	3	1	4
<b>Transit Time</b>	3	2	4	1
<b>Reliability</b>	2	1	4	3
<b>Capability</b>	1	2	4	3
<b>Accessibility</b>	2	1	4	3
<b>Security</b>	3	2	4	1

1 = best, lowest

4 = worst, highest

The ranking describes the relative benefits and weaknesses of each mode based on the determinants. The transfer chains are presumably constructed according to the lines defined in the ranking. For example the cost advantage water transport has over the other modes is turned out in the world trade in high volumes of relatively low value goods transported. Respectively goods with high value and which therefore are urgent are transported by air. The selections criteria may however in individual cases (transfer chains) differ from that - like the accessibility as a selection determinant may be influenced by geographical facts. For example a plant located besides a major seaport with connections to the market area, may find water transport attractive in accessibility but also e.g. in terms of transit time. Similarly transit time to a nearby destination by air may turn to be unfavorable compared to e.g. rail delivery between terminals.

It is seldom that individual customers alone are served throughout the entire supply chain (except in project transfer). Typically transfer tasks are combined in different stages in order to construct transfer chains with bigger volumes. The related scale economies and the therefore defined total costs are in many cases dominating criteria for selection of transportation mode or combination of them (based on the specific cost structures of

each mode). According to Coyle et al. (1994) in the motor carrier industry from the operator point of view approximately 70 to 90 percent of the costs are variable and 10 to 30 percent fixed. Infrastructure investments (highway system) supporting the low fixed costs are made by public instances. In addition motor carriers do not require expensive terminals. The highest single cost element is labor cost (approximately one fourth of total costs) and therefore the motor carrier industry is labor intensive. They address that the cost structure of railroads is the opposite to motor carriers – it is believed that closer to 30 percent is variable and therefore approximately 70 percent fixed costs in the short run (a period when both plant and capacity remain constant). The reason for this is that, along with the pipelines, railroads are the only modes that own and maintain their network and terminals. Labor cost is the largest single element of variable costs, however due to the low share of variable costs railroad industry is not labor intensive. Further they address that the air carriers' cost structure consists of high variable costs, approximately 80 percent and low fixed costs, approximately 20 percent. The relatively low fixed costs are caused by government (state and local) investment and operations of airports and airways. The fees paid by carrier for the use of these facilities are variable in nature. The airline industry tends to be labor intensive compared to some other modes of transportation. Finally they state that water transportation is generally the lowest transportation cost mode for the non-liquid cargoes. Water carriers do not provide their own highways but the public aid is in the construction and maintenance of waterways and (partly) port facilities. Therefore the cost structure consists of high variable costs and low fixed costs. Water transportation is not labor intensive, although labor is required at the terminal for loading and unloading of cargoes and transfer to other transportation modes. In the comparison based on total costs (and corresponding service level achieved) between entire transfer chains also the public money spending should basically be included in the calculations. In individual cases or certain market areas the competition between transportation modes may be distorted - like intentionally in the congested Middle-Europe due to environment policy reasons.

In the example transfer chain of Figure 2-7 it typically a water carrier is employed in the main leg. In addition to the main leg (e.g. deep-sea) there may be feeder legs on both sides depending on for example the geographical conditions. In maritime transportation volume is an extremely relevant issue. Especially in deep-sea shipping companies have

tried to attract higher cargo volumes in order to facilitate the purchases of bigger ships with lower expenses for a slot, higher freight income and increased profitability. They have done this however in the cost of bigger operational risks in case of turbulent demand environments. This issue is discussed in Chapter 5 where is also investigated the influence to cargo carrying capacity either by investing in the cruising speed with improved ship hull design and engine power or in the efficient cargo handling at port, both resulting in a higher number of annual round trips. The timing and routing issues are relevant depending on the supply chain and cargoes carried. Significant differences in the transfer chain structures may be as a result. In sea transport there is roughly two alternatives - liner shipping and tramp traffic. The first follows preset schedule between fixed ports. The goods flow with the sea leg are interlinked and preferably scheduled accordingly. Typically a permanent system with significant investments is constructed in the terms of physical facilities but also concerning information flows to support the efficiency and reliability of service presupposed by the customers. Tramp traffic on the contrary is not systemized and is less interlinked with the surrounding traffic flows. It fulfills transportation tasks according to the demand. Therefore there is not fixed schedule neither traffic between specific ports, but it may utilize common facilities.

The pre-carriage and on-carriage phases are typically either rail transport or truck transport. If the physical characteristics of goods to transported, economy in general and the geographical and accessibility conditions allow, air transport alone may replace several phase in the transfer chain. However the phases closer to the customer are likely to be organized similar to with the other alternatives. Inland water transportation and short-sea shipping may also compete with the land transport methods. This applies especially in case of longer transportation distances (cost benefit) and if congested areas can be avoided (competitive transit time), or if this mode can be more efficiently interlinked within the transfer chain. It is likely however that the following phases utilize truck transport mainly for the cargo flows turn too thin for rail or water transportation and the accessibility requires more adjustable truck transportation.

The cargo handling methods used and equipment available in transfer nodes has a great influence to which transportation modes and forms are feasible. Brooks (2002) states that for many years the ratios for shipment characteristics were used to determine when

the breakbulk and general cargoes would be converted from tramp vessels to a container format. She also argues that some growth in container volumes is attributable to such conversion or penetration of containerization but the future growth is unlikely to come from this source. The value to density ratio of most general cargoes not yet containerized is not suitable for that meaning that the traffic growth for liner companies is limited. However harmonization of cargoes to be transferred, e.g. using standard container units, has been of a nature to ease the construction of transfer chains for service qualities and efficiency. In intermodal transportation - where the cargo remains untouched but the cargo unit is handled with standardized methods and processes - potentially several different modes are interlinked together. The target is to achieve feasible combinations of cost efficiency, transit time, reliability etc. In regional transfer truck-rail –transport combinations are typical, for example in Middle-Europe. In transfer chains involving short-sea shipping, truck-water –combinations are dominating although rail-water and inland water-sea water transport combinations are also used.

Last mile transportation needs are satisfied in business-to-business mostly with different kinds of courier services. In consumer sector most responsibility is given to consumer. Self-service is common in the last leg from retail level to home but also during the first phase from consumer onwards. Examples are e.g. the waste recycling of households or letters taken to letter box. In countries with high labor costs and taxation, groceries are mainly transferred home in self-service but the adoption of home deliveries seems to be also linked to service culture and customer preferences of companies. Tesco and some other grocery stores offer home delivery services also in less favorable conditions.

According to Brooks (2002) the world is moving towards a service economy and, in general, service economies do not use sea transport. She states that the new job growth is in economies and industries that do not contribute to shipping ton-miles – software, pharmaceuticals, education, biotechnology, tourism, recreation, and business services. Similar argumentation is used in this thesis concerning the Transfer Service Matrix (TSM). This is; it is likely that there will be a relatively higher growth in transfer transaction volumes for more harmonized and in physical dimensions smaller items. The importance of coordination mechanisms and supporting systems like in IT is also going to increase in order to gain better performance out of the more physical assets.

## **2.6 Matching the Elements in Transfer Chains**

The creation of a transfer or supply chain may be a complicated process. The parties to be involved are either systematically selected by a driving party, are market-driven established, or possibly long term business relationships have formed the supply chain over the time. In Chapter 3 Transfer Service Matrix is presented and applied for the analysis of transfer services in order to find corresponding channel arrangement for the service needs resulting in an efficient match of service offering.

Traditionally a company manages resources and processes to produce and supply the customers with the products or services required. In the current (typically regional but globalizing) economy, a growing part of the business is co-operation and networking with different organizations. The purpose is to satisfy the fluctuating customer needs continent- even world-wide. The challenge is to establish efficiently working entities out of the diversified parties involved in the business. Integration between parties has been offered as a solution to cope with the new requirements in supply chains but great deal of the discussion has been turned to questions of information system integration. Relatively limited emphasis seems to be given in the academia and among practitioners to the analysis of the nature of the gaps in the interfaces of supply chains. The purpose of this paragraph is to discuss the different functional characteristics transfer chains/networks meet in different business conditions in terms of integration. Different types of gaps in the supply chain interfaces are reviewed and potential solutions for more efficient transfer/supply chains - or networks are discussed.

### **2.6.1 The Diversified Dynamics of Transfer Chains**

The parties involved in goods delivery face different customer needs in the demand chain depending on the business conditions and customer industries in question. The requirement for goods transfer and delivery may vary from a relatively stabile and continuous process type of need to unpredictable and tailor-made low volume needs. Also the geographical coverage required for the service, the delivery time and accuracy



as well as the physical characteristics of the goods to be delivered may vary. In order to respond the needs and simultaneously keep up efficiency the supply chains should be formed respectively. An analogy can be taken from production environment where Fisher (1997) has illustrated similar challenges by dividing the types of supply chains roughly into two depending on the product type to be delivered (Figure 2-8).

	Functional products	Innovative products
Efficient supply chain	<b><i>MATCH</i></b>	<b><i>MISMATCH</i></b>
Responsive supply chain	<b><i>MISMATCH</i></b>	<b><i>MATCH</i></b>

**Figure 2-8** Matching supply chains with products (Fisher 1997)

Fisher divides products into two categories; functional and innovative. The former is with predictable demand patterns, relatively long product life cycles, low margins and low product variety. The latter is with unpredictable demand, short product life cycle, relatively high margins and big product variety. The two types of supply chains are the physically effective one that supplies to predictable demand efficiently at the lowest possible cost and the market-responsive one quickly responding to unpredictable demand in order to minimize stock-out, forced markdowns and obsolete inventory (Collin 2002). This division is applied here in the physical transfer chain. The different types of products are translated respectively into different types of transfer services for the demand of transfer services is conducted from the demand of commodities.

This kind of diversification however has not always been successfully implemented in real life as e.g. Tan and Gwee (2002) conclude: ‘In a traditional channel of distribution, even

if logistics activities are well managed, there is still a lack of coordination and integration between organization which may lead to increased costs and decreased level of service. The traditional channel is normally managed by a push inventory control system in which pre-set safety stock levels and re-order points determine what will be produced and each channel member tends to keep relatively large safety stocks to guard against demand variability. Operating the channel under these conditions tend to result in what is called the bullwhip effect, where order variability is magnified throughout the channel such that a small increase in demand at the consumer level results in a disproportionately large increase in demand elsewhere (Lee et al. 1997). The consequences of such an effect are increased inventory, increased transportation costs, and inefficient allocation of resources.'

In terms of collaboration and inter-linking the challenges in the supply chains are more diversified and difficult to solve than e.g. in manufacturing in the factory environment. The elements in the transfer chain should be balanced for two direction material flows contrary to typical manufacturing plant. More importantly the transfer or supply chains are seldom controlled by a single party, but involve several organizations. Friction is frequently experienced even within a single organization between functions or over the department boundaries. It is therefore a challenge to find a solution for functioning cooperation in the interface (parallel or sequential) between two organizations. Interfacing should depend on the prevailing circumstances and vary for different types of supply chains. Where frequent changes in the demand are expected it is suggested to have a loose relationship between parties thus allowing quickly re-allocation and re-combination of resources for the most promising business set-up. On the other hand in expectedly stabile demand conditions, the co-operation between parties could lead to a long-term relationship in order to streamline the processes to form a functioning entity for mutual benefit. Using the division by Fisher (1997) when (cost) efficiency is required supply chain integration is commonly suggested as a solution. However when responsiveness in the supply or transfer chain is expected, presumably something else is required. In that sense compatibility between organizations is discussed here.

### 2.6.2 Compatibility in Organizational Interfaces

Benson et al. (1994) introduce two types of gaps in supply chain management. Stern and Heskett (1969) propose three kinds of conflicts in different goals and decision making in the inter-organizational relations: difference between members' goals and objectives (goal conflict), disagreement over domain decisions and actions (domain conflict), and differences in perceptions of reality used in joint decision making (perceptual conflict). There is however more gaps that need to be overcome in the organizational interfaces in supply chains. The barriers that tend to inhibit efficient cross over the interfaces should be identified and analyzed in order to systematically eliminate their influence. The subject has been touched in many studies and investigations in academia and practice. Most analyses however has been conducted case by case from a special perspective – common is analyses of information system compatibility and related discussion of system integration. The compatibility issues are not widely discussed probably because of the problem touches many different disciplines. The transaction cost economics (Williamson 1985) however deals with similar issues in the organizational relationships, the friction can be interpreted as compatibility issues. These can be further translated into transaction costs. Although not argued using the terminology of transaction cost economics, the following approach has a lot of points of contact with that orientation.

In the following several compatibility issues involved are discussed. To facilitate the discussion let us assume that two organizations are in the same supply chain. Solving the compatibility challenges influence the ease of establishing working entities. Mutual interests is a somewhat prerequisite for organizations to start to co-operate. It closely relates to company strategies therefore being called here the *Compatibility of organizations' strategies*. The *Compatibility of interest and targets of organizations and individuals* in several levels is also identified. In order to bridge the potential gap, adapting to the other parties tactical and operative level goals is required. Closely related is the *Compatibility of service concepts*. Similar strategies in short term decision making and the prevailing business conditions may form the service concepts of two companies different. The *Compatibility of quality and environmental issues* is to ensure that

customer satisfaction and smooth operation with minimum defects and disturbances is achieved. The specified control and steering is typically supported with quality and environmental systems. The *Costs compatibility* is also closely related to strategy. The ability to price the service competitively to adjust with the other parties may be crucial. Otherwise the feasibility of the whole service entity may be ruined. Respectively the *Financial compatibility* deals with that the parties have the required financial resources. This is especially important when longer term co-operation is to be established.

The *Technological compatibility* concerns both the equipment and infrastructure involved in transfer operations, and the technological infra- and superstructure in IT. Utilization of common technology bases or technologies with in-built flexibility is beneficial. The *Information syntax compatibility and language compatibility* allows transferring information between information systems or individuals so that the messages are correctly translated. Common syntax or language chosen, or efficient translation is the likely solution. The *Semantic compatibility of information* involves that the content of the message is correctly understood. In order to avoid such a situation coding and interpretation of the information need to be agreed. The *Geographical compatibility* is a basic prerequisite of physical presence of the consecutive parties in the geographical spot. Many times in practice the parties already offering services in the market in question are selected. In operational level this often merges with the *Compatibility in timing* where the resources required for the service are timely offered. The *Compatibility of capacities* ensures that resources with adequate capacity are available in order to facilitate transfer between transport modes of potentially different capacities. *Organizational compatibility* is a lot subject to business concepts but also deals with the number and organizing of people employed to facilitate communication between organizations. Supporting that the *Compatibility of abilities and skills* ensures the abilities and skills enable co-operation with other party in the required level. This uses training and precise recruiting for the diversity of skills and personalities.

*Cultural compatibility* is a challenge faced within private enterprises in their relations with official organizations and between nations and cultural areas. These include work cultures, practices, priorities etc. In order to overcome the challenge, education can be used to increase common understanding. The *Compatibility of legislation* typically

challenges supply chains when national boundaries are crossed. It involves e.g. work practices and equipment allowed. This comes together with the interpretation of legislation. A lot of the *Compatibility of security and safety practices* is motivated by increased threat of terrorism but also to ensure prevention of accidents related to e.g. hazardous cargoes. This is partially based on legislation but also international security protocols and rules. The *Compatibility of information security practices* between organizations is to ensure confidential information is not delivered to false parties or that computer viruses disturb information transfer or destroy data bases and files.

### **2.6.3 Overcoming the Compatibility Challenges**

The organizations in transfer chains have different roles – they physically move goods, or offer supporting services or basic structures for transfer. Authorities e.g. control that the operations follow the law and rules. Transfer chain is therefore a combination of various work phases where the cargo is - possibly several times - transported, handled, lifted, inspected, controlled by customs, packed and lashed etc. The compatibility issues discussed above are relevant in several parts of the chain. It is also common that compatibility challenges are bridged without actually segregating them. In the following is discussed of some common approaches to overcome the compatibility challenges.

A variety of agreements are made in transfer services that cover anything between entire chain over a defined period of time and single delivery of a shipment. They are also means to ensure several aspects of compatibility. The responsibilities to customers reach over the boundaries of the agreement parties. The agreement party is responsible for the customer for example of the accuracy of delivery that may be dependent on the performance of the other parties involved in the chain. Laws and regulations are prescribed according to which lines the parties have to behave in their relationships.

Standards are typically developed in co-operation and promoted by international consortiums. They are perhaps the most important means to bridge gaps between organizations. ISO (International Organization for Standardization) ([www.iso.org](http://www.iso.org)) standards is described to contribute in making the development, manufacturing and supply of products and services more efficient, safer and cleaner. Trade between countries is easier and fairer, they support governments with a technical base for health,

safety and environmental legislation, and aid in transferring technology to developing countries. Introduction of ISO sea container has significantly influenced to physical transfer chains but also to business processes, organizational structures, world trade, etc. Another relevant standard is the Supply-Chain Operations Reference-model (SCOR) developed by the Supply Chain Council (SCC) ([www.supply-chain.org](http://www.supply-chain.org)) as the cross-industry standard for supply-chain management. RosettaNet ([www.rosettanet.org](http://www.rosettanet.org)), a consortium setting global standards for the exchange of information via Internet among the computer and semi-conductor industries has similar targets. EDIFACT-standard used for defining semantics in electronic data interchange however has been implemented with high costs in specific point-to-point versions. The standardization process is not easy to plan. A participant in 3G telecommunication standardization stated it is not a straightforward or cumulative process but iterative cycles and wasted efforts are usual (Fomin et al. 2003). The big global companies have internal standard-like practices; the work culture is gradually harmonized and a company language (e.g. English) is used at least in international connections. The new management methods in the global competition are also spreading rapidly. Microsoft's software products have gained almost monopoly in office environments thus several global work procedures are harmonized. In SCM however such systems are not available although commercial software packages are developing. Commercial packaged software solutions are available to bridge the organizations in terms of information security. The battle however is continuous against especially computer viruses to prevent IT systems.

The quality systems have history in maritime transportation - in shipbuilding where the ships were classified by classification societies - today they also certify quality systems. Classification entails verification against a set of requirements during design, construction and operation of ships and offshore units. The quality systems ensure that companies having quality certificate fulfill certain quality wise important requirements in their businesses processes. This is to tell to the potential business partners that there is no gap in quality compatibility assuming the level the standard set is sufficient for establishing co-operation. Preferably the most widely spread standards for quality systems are ISO 9000 series systems and for environmental systems ISO 14000 series.

Shipping has been in the front row also in defining safety and security rules. IMO, the International Maritime Organization ([www.imo.org](http://www.imo.org)) has adopted the International Convention for the Safety of Life at Sea (SOLAS), the most important of all treaties in maritime safety. The main objective is to specify minimum standards for the construction, equipment and operation of ships, compatible with their safety. This initiative concerns carriage of dangerous goods in packaged or in solid form or in bulk. The International Maritime Dangerous Goods (IMDG) Code, by IMO International Safety Management (ISM) Code, requires a safety management system to be established by the shipowner or any person who has responsibility for the ship. The latest initiative under IMO is a security regime, International Ship and Port Security (ISPS) Code that came into force in July 2004 after the adoption of a series of measures to strengthen maritime security and prevent and suppress acts of terrorism against shipping.

Isolated technological solutions create interfacing challenges in supply chains, but technological (standardized or flexible) approaches may also bridge the gaps. Some innovations are integrative by eliminating number of transfer phases, reducing interfaces or otherwise streamlining the process. Automated communication between systems has in some environments nearly eliminated human intervention. Like in modular manufacturing; modular transfer services allow a sub-process or function to be connected to the surrounding processes using the defined interfaces. In physical transfers this is a lot of technological issue for efficient transfer of goods requires similar capabilities between two phases. In ISO container units standardized lifting points and dimensions help in cargo handling and transportation to lift or move the unit.

Forwarding companies have traditionally had the coordination role in transfer chains. This includes selection of compatible members to perform the transfer tasks. This work has in many cases become easier for the development of similar procedures and compatible technologies has reduced the integration barrier. As the variety of skills and equipment required is reduced, various forms and sizes of organizations - networked and integrated – benefit. Intermodalism is a general term for means of transportation, with increased compatibility, where unitized cargoes are transported and transferred from one mode to another in the same unit from the shipper to the customer. The challenge is to cut down needless work phases, keep goods moving and reduce delays and make the

cargo handling easier and more secure by means of unitized cargo (Muller 1989). Several integrative elements are used - unit loads for physical integration, telecommunication for informational integration, integrated service providers for economic and organizational integration.

#### **2.6.4 Vision - The Supply Chains of the Future**

Ownership has traditionally supported integration of value chains. In transfer chains this is reflected especially in vertical integration. Australian Patrick Corporation speaks about total transport logistics (Patrick Corporation 2003, [www.patrick.com.au](http://www.patrick.com.au)) where they own and manage an integrated chain of complementary businesses enabling to eliminate inefficiencies along the chain and offer customers comprehensive transport logistics solutions. A Finnish door-to-door container shipping company Containerships Ltd. Oy ([www.containerships.fi](http://www.containerships.fi)) took in operation a widespan ship-to-shore container gantry crane in one port. Previously a communal organization provided the service, but the company had their own ships and own stevedoring. Important in decision making was that the number of organizational interfaces were reduced, related compatibility challenges and interest conflicts were removed, and an organization in the chain with different work culture was avoided. The solution paid back with significantly higher efficiency. The drawback of expanding ownerships could be however the commitment to a geographical location with reduced opportunities to react changing conditions.

The purpose of supply chains (SC) is to fulfill the demand created in the demand chains. In stable demand circumstances, push strategy in the supply chain can be used. Parties involved in supply chains may form permanent ties and the compatibility gaps detected can be bridged with integration over the company interfaces. However in high demand uncertainty pull strategy together with a structure that allows more flexible reallocation of resources is preferred. The various supply chain evolution models give a simplified and harmonious view of the business environment. In real life companies face demand patterns that would distort the picture completely. Therefore it is possible that several companies, even entire sub-industries, remain to function with traditional business logic. Big global supply chain players and companies in the media and software industries for example have grown significantly with consolidation through acquisitions and fusions. If



there are resources enough this offers opportunities to increase turnover that otherwise wouldn't be achieved. Another explanation is that in some environments due to the compatibility challenges the production of services (or products) is more efficient with integrated solution than with the network alternatives. They may even avoid the challenges caused by market fluctuations. Strong enough player is able to influence the rules in the market (Microsoft in the home and office software industry). Besides a truly global company is more immune to fluctuations in one individual market for it may be able to reallocate resources to meet the demands of the most dynamic markets at a time.

Pearson and James (2002) however state that the efficient management of supply chain assets, traditional focus of most supply chain providers, is no longer a source of competitive advantage. According to them Kingmakers are companies who own supply chain information and collaborative partnerships, but not necessarily the assets. Tan and Gwee (2002) address that leading-edge company uses information to integrate the activities and processes of supply chain members in a way that creates a seamless flow of products synchronized with actual demand. An international consultancy company Forrester ([www.forrester.com](http://www.forrester.com)) suggested in 2001 in different forums a paradigm shift from the conventional supply networks to adaptive networks. The former are actually chains that are tightly coupled (or not at all), hoard knowledge and are haphazardly coordinated. The latter are loosely coupled communities, share knowledge and intelligently adjust. The macro trend requires flexibility - the capacity rapidly transforms oneself to respond to changed conditions, something that current supply chains cannot provide. They suggested that static supply chains are dead and the roadmap is towards adaptive networks with high-exposure to variability and decentralized decision-making. They offer information systems as main solution but also state that the current supply chain applications ignore the "physical world" with e.g. millions of trucks and cargo ships and billions of containers and pallets. They see the unique characteristics of an adaptive supply network as event-driven and self-regulating. The German software giant SAP has supported these views (Harper 2002). Adaptive networks require e.g. to establish real-time integration across the entire supply chain network and simplify and standardize allowing for flexibility. Also according to Andersen consulting (2002) competitive advantage will be driven by the combined capabilities of the extended supply chain, not just individual companies. The scope of parties to be impacted increase

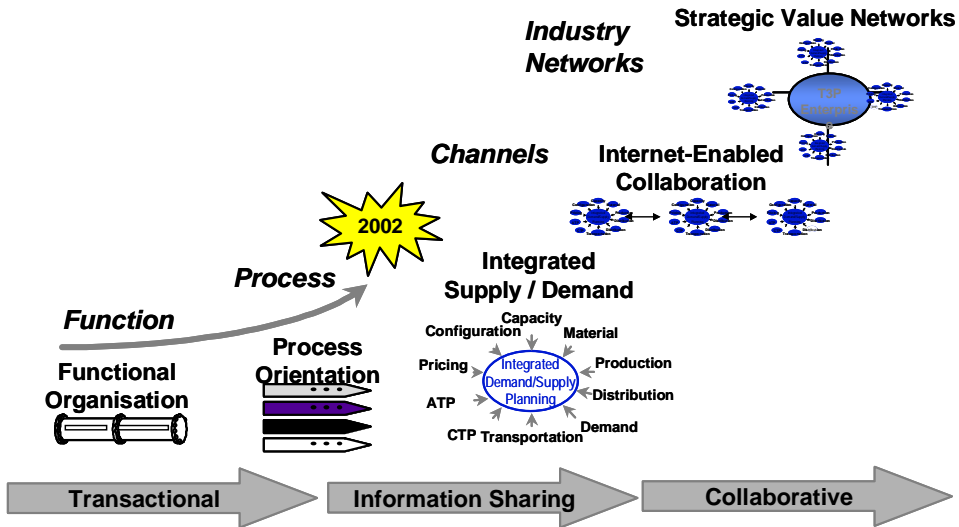
together with the relationships along the supply chain and the solutions created. The more parties involved in the supply chain network, the bigger the benefits achieved.

There is a variety of strategies introduced in order to facilitate efficient supply chains in different circumstances. *Integration* has achieved a lot of attention both in academia and practice of SCM. The concept is vaguely used in different kinds of relationships between organizations from strategic level discussion through tactical and operational initiatives to detailed technical linking. Interpretation here is that integration describes closely interlocked relationship between parties involved. The expected duration of the relationship is likely to determine the depth of integration between organizations. In some IT projects the tight integration is transformed to ballast stiffening the SC structures. Viswanadham and Gaonkar (2002) state that such systems are very expensive to maintain requiring dedicated links between each of the SC partners. More importantly relationships cannot be formed dynamically with new partners according to customer requirement. *Synchronization* - claimed as the highest level of relationship - is supported e.g. by John L. Gattorna (2004). Tan and Gwee (2002) see that (efficient) production at all levels is synchronized to the actual consumption or demand at the consumer or end customer level. This would mean that members of the SC have real-time visibility to actual demand and that activities can be integrated and coordinated. This eliminates the bullwhip effect by reducing uncertainty and lead times, but also ensures that the final product is what consumers want. Holmström (1995) states that operational uncertainty and inefficiency are to a large extent a consequence of self-induced uncertainty caused by demand distortion in supply chains and unsynchronized planning, congestion by quality problems and rework, and complexity imposed by designs and processes. He makes a division to low (decoupling of dependent activities, accumulation of needs) and high efficiency operations (synchronizing dependent activities, direct communication of needs). In an integrated, closed environment with few parties and limited number of resources *optimization* may produce feasible solutions. However when the dynamics is increased, number of tasks stretched and several parties with all different incentives, goals and targets, technologies etc. involved, finding a single solution gets challenging. The optimization task of an open problem will explode so that solution is not reached with the current algorithms and computer power available.

Companies concentrating to *core-competencies* allocate their (limited) resources to the businesses they are good at or they tend to operate. The rest what is required are purchased outside. In *networking* e.g. companies with similar core-competencies may increase their geographic coverage by creating links to others servicing the customers in the target areas. Alternatively the activities can be spread to a wider range of services. The latter is approaching *sub-contracting* where the services required are bought from the market. It is also common to use sub-contractors besides the own service production in order to create flexibility in varying demand conditions. The potential compatibility gaps however are to be solved somehow. Therefore standardization that enhances *connectivity* is a potential strategy if changes are expected in the business environment. Connectivity is usually thought to be technically oriented however it may describe all aspects of linking the parties. It allows temporary relationships but serves and facilitates also integration and by nature supports collaboration. *Modularization* with standard interfaces has the in-built connectivity of wider entities. It allows multiple combinations in flexibly and easily formulating and creating systems to satisfy customer requirements.

*Collaboration* – a concept introduced lately - implies more loose relation between organizations than integration and is preferably bridging gaps of more immaterial nature. In collaboration parties are looking for common benefits by sharing information of their short term business prospects (like sales, stock levels, etc.) and co-operating also e.g. in compatibility of information system and business practices. In operative collaboration the inter-organizational linking is increasingly facilitated over the internet.

The interpretation of the author of this thesis is that depending on the type of demand/supply either integrative efforts or preparedness to change is required. The motivation for the development work is illustrated in Figure 2-9 in terms of benefits to be achieved in different development stages in the foreseeable future.



**Figure 2-9** The Benefit Development in Supply Chain Evolution  
(Andersen Consulting 2002)

A potential development starts with the traditional function and internal process based view in supply chain turning to more external view for benefits creation. According to Viswanadham and Gaonkar (2002) an integrated supply chain is a group of independent companies (often in different countries) that form a strategic alliance with the common goal of designing, manufacturing, and delivering right-quality products to customers faster than other alliance groups or vertically integrated firms. They can efficiently facilitate push strategy. Next the integrated demand/supply planning eliminates the situation where especially marketing and sales, and goods (or service) production live separate lives. The demand/supply chains are further inter-linked using internet-enabled collaboration allowing more intensified resource allocation with utilization of a wider coverage of channels. The benefits and efficiency are further increased in strategic value networks possibly constructed around public marketplaces. These are - assuming connectivity capabilities - open for all parties. According to Viswanadham and Gaonkar (2002) public marketplaces provide a platform for companies to locate, manage and collaborate with their partners. The first marketplaces during the last years have been mostly closed clubs with a limited scope. They have covered a few functionalities only

like purchasing of raw material or components for a particular industry. The open many-to-many supply networks with also the physical transfers are yet to be established. Over time they presumably appear and are supported with automated processes and intelligent agent technologies they minimize human intervention. Combined with identification using radio frequency (RF) or similar tags and wireless machine-to-machine communication, the supply networks are likely to be revolutionized.

### 3 Analyzing Physical Transfer Services

This chapter is based on an article by Jouni T. Laine, Ari P.J. Vepsäläinen and Anu H. Bask "An Analysis Framework for Physical Transfer Services" published in the Proceedings of the 15<sup>th</sup> NOFOMA Conference, ed by Juga, J. , pp. 368-383, Oulu 2003.

Most of the production of goods, raw materials, information and services has been specialized and diverged geographically. Therefore different kinds of commodities need to be transferred to meet the consumption. The collapse of dotcoms showed that new means in marketing, sales activities and the early phases of the order-delivery process alone is not enough. Performance and efficiency is required in the purchasing, manufacturing, storage and delivering the goods as well. This however may still prove to be challenging despite the long history and many commonly accepted practices. In the chains of several transportation and cargo handling stages the current co-operation between companies may be complicated; connectivity needs to be improved and information systems don't shake hands. As the surrounding world with changing customer requirements and frequent innovations is in continuous movement, long traditions in physical transfer may even retard the development - the organizational structures and technological set-ups may be too fixed and attitudes difficult to change.

Lately developments seem to have been driven by either customer needs or production. Industrialization of service production during the last decades touched deeply the transport sector. In the general cargo transportation a huge change was experienced when the cargo was unitized in standardized sea containers in the 1960's. This took place in terms of efficiency and productivity, ease of handling and utilization of carrying capacity especially in the port operations and sea transportation. The followed introduction of intermodalism with modal changes within the transport chain however raised the significance of organizational issues and innovations as a source of development potential besides technological innovations. Postal service (with letter handling) is an example of the changing business requirements and the resulting structural changes. It is today mostly outsourced instead of companies having own messengers and handling offices. It is also more stream-lined, automated and probably more strictly scheduled than it used to be some decades ago. Competition seems to drive

the service requirements - many customers require that similar logistics services are globally available and supported with fancy information technology. As a result some logistics service providers get specialized while some others get more in to the orchestration of different logistics services like flow of inbound goods, parts delivery, management of supplier parts, final assembly, repacking, labeling etc.

The issue raised is the capabilities needed for the service production of the physical transportation and handling operations – here called *physical transfer* of goods – to meet the customer requirement. In order to get to grips with the subject a matrix type framework is introduced. In the framework diverse transfer needs are matched with appropriate transfer organizations and channels. It enables to classify, visualize and analyze physical transfer services. It also helps to figure out the past development of physical transfer and position the current services in comparison to – what we believe are the efficient modes of transfer service production. The target was to create a matrix framework for transfer services - similar to what Hayes & Wheelwright (1979) did in their framework for production, so called Product-Process –matrix. As an outcome the Transfer Service Matrix (TSM) allows, together with examples, to illustrate the efficient equilibriums when matching the service needs with appropriate supply.

### **3.1 Literature of Models for Transfer Services**

Literature is briefly reviewed in order to have a look at some relevant models – their primary purpose, scope, strengths and possible limitations – as a reference to the Transfer Service Matrix. Some definitions however need to be clarified. Klaus and Mueller-Steinfahrt (1994) divide logistics into *transfer* and its supporting functions, where the transfer may be in space, time or size. In their definition transportation, warehousing/inventory and packaging/assortments are examples of transfer. This is slightly different to the definition presented here. Here with *physical transfer* (or *transfer*) is stressed the physical nature of transportation and handling operations of goods (and thus separate from the information transfer also related to logistics activities). This definition doesn't directly involve warehousing/inventory, but are seen indications of inefficiencies in the connection points of transfer phases.

In the literature of services, transfer services (transportation and related services) are typically not analyzed separately, but the entire range of services has been classified and analyzed. It is not either clearly addressed that services and the production of them may vary significantly also. Within a certain service sector e.g. the business logic and development drivers, set-ups, limitations and investment needs may be completely different. Although sometimes feasible to keep service analysis in an aggregated level, concerning an individual sector the risk is that important features are left unrecognized.

In a service analysis by Silvestro et al. (1992), data from 11 service organizations were used to rank the companies by the volume of customers processed per day in a typical unit on an ordinary scale. Transport and transport terminus showed low values for contact time, customization and discretion compared to most other service companies. Equipment focus, back office and product focus were also classifying attributes, indicating that also the physical dimension of these services was recognized. In their classification together with confectionery, tobacco, news retailer transport and transport terminus represented 'Mass services' when the other classes were 'Service shop' and 'Professional services'.

Schmenner (1997) use the same division as Silvestro, but adds one more service process type, 'The Service Factory'. He suggests there are services with relatively low labor intensity (a greater fraction of service costs associated with the facility and its equipment) and a low degree of customer interaction and customization. The four service processes are defined as quadrants in a two-by-two matrix where he contrasts the labor intensity and the degree of interaction with and customization of the service for the customer. According to him much of the transport industry are service factories. In the matrix e.g. airlines and trucking are in quadrant of low "Degree of Contact with, and Customization for, the Consumer" and low "Degree of Labor Intensity". Schmenner also describes the managerial challenges posed by different types of services, however without specifying any general directions for future changes. Hence there are no differentiated views of, say, logistics and transport services describing the development of different service strategies. There is just the observation that airlines and trucking tend to be organized as "service factories", characterized by hierarchical management and rather rigid standard operating procedures. In his opinion, many services require little in



the way of capital investment, multiple locations, or proprietary technology. As an example of the rather low service entry and exit barriers he gives that airplanes and trucks are assets supposedly easy to sell off. Applying this definition to, for instance, terminal networks and seaports with highly specific fixed investments, is seen problematic in this dissertation.

Cooper et al. (1991) classify logistics and transport services by a two-by-two matrix where the geographical coverage (narrow to wide coverage) is on the other axis and the development stage of the portfolio services on the other axis. Different types of transport service companies can be positioned in the matrix. It is possible also to present the current positions and out-line the development of companies. This is done for some named companies that were believed (around 1990) to reach for “Mega-Carrier quadrant”. A trend towards a wide portfolio of service product offerings and geographical reach for most carriers is identified. However, it doesn’t give any indication as to the efficient strategy for individual companies considering attributes such as types and volumes of cargo, or organizational and technological life cycles.

Tinnilä (1997) presents a Service Process Analysis Matrix for classification, positioning and analysis of service types (based on complexity and contingencies involved) and delivery channel (organization and the interconnections among them). The matrix was also used for positioning and analysis of logistics and transportation services. He visualized that the earlier multiple services provided by transport and trucking companies have been broken down into several specialized services. Analyses do not include variables like infrastructure and technological resources, routing and scheduling, features of the product to be transferred etc. The model is more general focusing on ordering phase.

Hence a wide range of factors affect the form of the emerging logistics and transport sector and the transfer services offered. In the frameworks described above several issues has been neglected in the area of logistics and transport services. In the above frameworks: (1) The focus has been in the investigation and classification of services in general - transport and logistics services are only mentioned among other services and in most cases the examples have presented single stages or companies of the transport chain. (2) Contact to the customer in service offering has been one of the principal view

points and customer is respectively involved in the service processes analyzed. (3) The divergence of services within the transport and logistics services sector as such is not analyzed in frameworks except that Cooper et al. (1991) distinguished the service companies according to width of service portfolio and geographical coverage offered.

The provision of transfer services combines features of internal production with customer needs. Therefore a proper analysis of transfer service production would combine the approach of the Product-Process-matrix (Hayes and Wheelwright 1979) with the model of Service Channel Strategies by Apte and Vepsäläinen (1993). In the matrix Hayes and Wheelwright describe the interaction of product and processing structure, and the product life cycle with the process life cycle. On the other axis the product structure/product life cycle stage actually takes into consideration of what kind of features the products to be produced have, namely volume, level of standardization and uniqueness. On the other axis there is the process structure/process life cycle phase. That describes the continuity of the production and therefore also indirectly considers the production batch size. The generic products representing efficiency in the production of goods - whose product features match with the production type - are in the diagonal.

## **3.2 Specifying the Transfer Services Matrix**

The purpose of the Transfer Service Matrix is to classify different transfer types and different transfer channel types in order to position current transfer practices, analyze whether the transfer solutions are produced with efficiency and outline future development directions. The approach is a high level conceptual view of the accomplishing of transfer services starting with the customer service need on the other side and the capability to supply the service on the other.

### **3.2.1 Essential Elements of Physical Transfer**

The manifold descriptions of logistics and transportation service production systems with various elements in different levels presented in the literature are simplified here. This is done in order to recognize some key elements that are definitely involved in the physical transfer of goods. *Transfer needs* means for example that a machine has to be moved

from the manufacturer's site to customer's premises within a given time. An organization or consortium of organizations - *Service organizations* - with the labor available is required to offer the transfer service. Correspondingly in most of the physical transfers at least some *Technological resources* (superstructure) are required, but they may also be means for vital transfer of information required to support the physical transfer (handheld mobile devices etc.). Finally *Infrastructure* (roads, ports, channels, telecom connections, etc.) is required, offering the basis for building up and continuously supporting the services. All in all the development of organization, technology and infrastructure, and combined together define the capabilities to supply the services in order to fulfill the transfer needs.

Schmenner (1997) puts the four service process types he has used in a table for comparison of services based on their features. The features he classifies into five (service features, process features, customer-oriented features, labor-related features and management features). He doesn't recognize technology and infrastructure directly but there are some individual process features that indirectly point to them like "Capital intensity" or "Ties to equipment". In this dissertation is recognized that technology and infrastructure together with organizational issues have a significant role in service processes and production. However, depending on the service in question both the absolute and the relative importance of service organizations, technological resources and infrastructure vary. In some case e.g. organizational issues dominate whereas in another situation infrastructure or technology is the most significant element of the service production. The "glue" that ties together the key elements (in different proportions depending on the case) and also influence the formation of them are issues like business logic, ownership of companies and interconnections between them, co-operation of different organizations, management trends and prevalent business atmosphere, technological developments (e.g. IT and communication technology), standardization in several contexts, policies of the authorities, laws and regulations, geographical aspects, etc. The well functioning entity is most likely to be the key for successful service offering. Unlike in the Hayes and Wheelwright matrix for goods production, in the Transfer Service Matrix the customer need has a central role. Production of transfer service without demand namely doesn't make sense (transfer service is almost impossible to store). In the vertical axis of the Hayes and Wheelwright

matrix the number of companies involved in the manufacturing, ownership of production, physical distance etc. are not analyzed. In the Transfer Service Matrix however transfer chains are elementary parts of the business with connections over the company boundaries. Therefore it is taken in account e.g. the involvement of several organizations in the service production at the same time, the networking issues (ownership strategies) and the global coverage of physical networks.

### 3.2.2 Types of Transfer Needs

The investigation is limited to transfer (transportation and handling) of goods. It is widely accepted that the demand of transportation services is derived demand depending on the requirements of the goods. Due to the definition this applies to the entity of transfer demand as well. When goods are transferred from the point of origin to the point of destination, one or more transportation and handling phases - actually a portfolio of transportation and handling activities is required. In the following the different *types of transfer* are classified according to their features, such as:

**Special Transfer:** There is one-of-a-kind products that completely differ from the products produced previously. The configuration is unique based on specialized customer specification. Therefore the production (production facilities, technological resources and organization) is arranged case by case to meet the requirements. The production process is of a project type or follows engineer-to-order/design-to-order approach. The physical dimensions, care of handling of the final product and the transport conditions required are something not previously experienced, and the final location of the delivery is typically unique. The transfer need is impossible to forecast, however the potential transfer requirements can be taken in account already during the design phase of the product. The need is to transfer a product or an entity with abnormal physical characteristics (in many cases complicated, heavy and big) once with special care through a unique planned route within a given schedule to the defined final destination. This kind of transfer need is called a Special Transfer.

**Customized Transit:** There are needs to transfer products that have reconfigurable features during the transfer. Products can be combined to be transferred with other

cargoes and are allowed to be stopped during the transfer for reconfiguring, handling or rerouting – transfers of this type are called Customized Transit. Such transfer needs separately represent low volumes and may require dedicated handling due to lack of packing or the special physical dimensions of the goods. The route can be adjusted or selected flexibly according to the requirements to the final destination.

**United Passage:** The need is to transfer products that are unitized (e.g. in order to achieve efficiency in handling) and united in standardized shape. The goods to be transferred represent significant volumes when combined with other unitized cargoes. Then they can be handled with standardized procedures and typically follow previously scheduled routes. These transfers are not sensitive to the transportation mode (can be switched to another mode) and don't necessarily require delivery from the point of origin to the final destination but allow repacking during the transfer.

**Item Delivery:** In the so called Item Delivery the shape of products to be transferred is uniform enough (like packages, probably of relatively small size) to allow simple transfer and handling in mass volumes. It is not necessary to specify anything else than the destination – transfer need is not tied to specific locations or schedules but goods have to be transferred continuously within a previously known delivery time frame.

### 3.2.3 Types of Transfer Channels

The supply of transfer services (capability to supply) is to be classified as well, and is called *types of transfer channels*. Transfer channel is not defined based on a single criterion, but it is a combination of organizational and technological (information, cargo handling, transportation technology) resources and related structures and processes. These mediate the transfer service offering. However the transfer channel is supported and is therefore dependent on the availability, features and development stage of the underlying infrastructure. Depending on the set-up of these elements it is possible to distinguish several types of transfer channels. Different companies and organizations together represent these channels, and some of them may be involved in several types of transfer channels in different roles.

**Adaptive Coalition:** The channel consisting of an organization or dedicated team with tailored transportation and handling equipment is called Adaptive Coalition channel. It is prepared to build together the elements (if available) or produce the elements of transfer and therefore the entity from scratch. The set-up of the transportation system may be so unique that such capabilities are not valued anywhere outside the organization (e.g. manufacturer of the products to be transferred) in question or it leads to forming up a temporary coalition. The capabilities of the configured system include capability to schedule the transfer according to the need and route from the point of origin to the final destination.

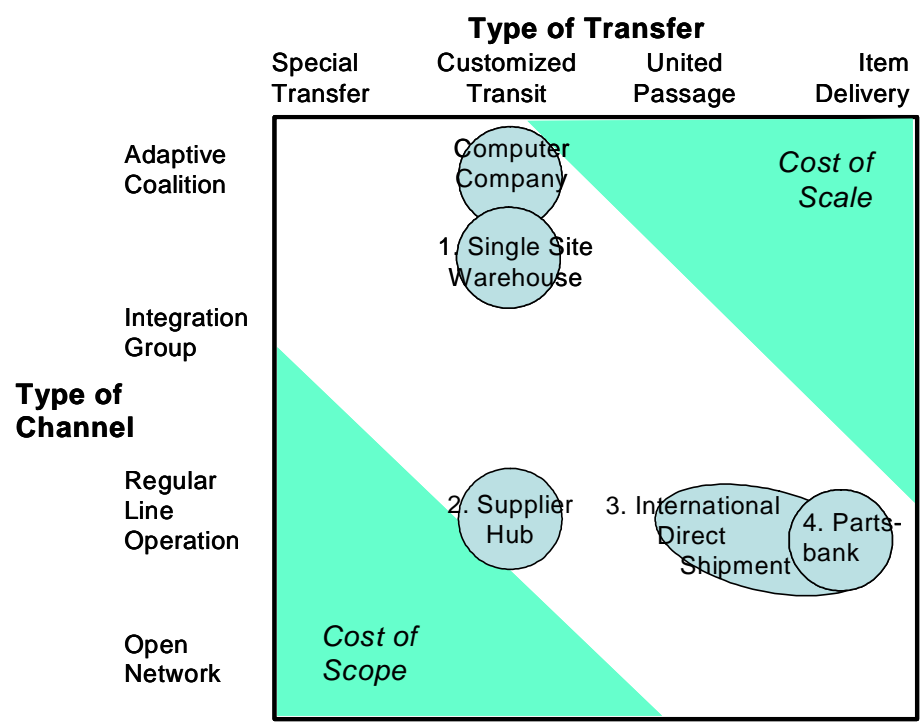
**Integration Group:** An arrangement where the existing organizational and technological resources are shared, combined and coordinated to form customized transfer processes is named an Integration Group channel. The network of third parties itself is not formed in a temporary basis but for a continuous availability of a wide transfer service offering over the limits of the organizations. The benefits are flexible allocation and higher utilization of the capacities through shared resources selected for the purpose. The capabilities include transfer flexibly according to the need within the network offered routing and scheduling alternatives (taking account e.g. the geographical and scheduling limitations and possible special care and conditions in transportation and handling required).

**Regular Line Operation:** This type of channel consists of in addition to the physical terminals, handling resources and organizational resources involved (field personnel) also the technological and organizational resources of the carriers and operators. There are networks with unitized processes capable to accumulating volumes of different kinds of cargoes. The processes are unified and interoperable to some stage. Through standardization of the resources an acceptable compatibility is achieved. The terminal networks are relatively fixed and the number of transfer (transport) connections between them is in practice somewhat limited. The scheduling is based on fixed timetables and typically offers frequency of transport in main legs and estimation on delivery time.

**Open Network:** An Open Network is open for every party to join to offer service capabilities without preliminary agreement. Participation involves adoption of certain defined standard protocols. Typical to this channel is uniform processes, a variety of

technologies used yet high connectivity and a wide geographical coverage (capability availability anywhere). Market mechanism is the resource allocating principle within the network. The intelligent agent technologies e.g. are supporting the scheduling and routing decisions through this network. Therefore the network offers a lot of alternative connections and opportunities for automatic routing. The delivery performance and delivery time estimation is highly based on probabilities (capability available anytime).

The types of transfer requirements and transfer channels described in the previous paragraphs set together a matrix called the Transfer Service Matrix, TSM (Figure 3-1).



**Figure 3-1** The Transfer Service Matrix with Example Logistics Solutions

The example logistics solutions positioned in the Transfer Service Matrix are adapted from a Stanford University case by Kopczak et al. (2000). The reference point is a *computer company* that faced a space shortage at its distribution center when the company was actively downsizing. It chose to hire a Logistics Service Provider (LSP) to

design, implement and run a bulk warehouse for its finished goods and a shuttle service to replenish stock at the distribution center from the new bulk warehouse, *1. Single Site Warehouse*. The activities in the LSP solution include labor and supervision; receiving, storage, shipping; VAS; and traffic/transportation. The benefits of the solution are lower labor cost, lower facilities cost, lower fixed/variable cost, and focus. However the single site warehouse is outsourced without any significant supply chain restructuring or sharing of assets/processes with other clients. In the second example computer company hired an LSP to design, implement and run a warehouse for incoming materials to be used for production of personal computers, *2. Supplier Hub*. The activities are the same as single site warehouse added with customs clearance; inbound and outbound logistics; and freight consolidation. Supplier hubs may also be used for coordinated supply of multiple products. Supplier hub involves significant supply chain restructuring as the suppliers share the hub and may use it as supply point to other computer companies as well. From a computer company point of view in addition to that the warehousing is outsourced and the warehouse shifts from a single-client dedicated warehouse to multi-client shared one, the suppliers own and have responsibility for the inventory until it is delivered to the manufacturing line. Also the LSP's information system and access to worldwide network of transportation assets and carriers is used. According to Kopczak et al. (2000) the benefits are delayed payment of duties and taxes, pay (for material) on production/sale, faster customs clearance, and visibility of pipeline inventory. In the third example semiconductor suppliers use small parcel/express delivery companies to perform international direct shipment of integrated circuits (ICs) from their factories to their customers overseas, *3. International Direct Shipment*. In this arrangement an LSP picks up outbound product from the factory each day at a pre-arranged time, transports to the destination markets, clears customs, deconsolidates the shipment and delivers to customers in the region. In some cases, ICs are shipped in bulk packaging, and later repackaged at the destination by the LSP. Therefore the activities are same as in the case of supplier hub, minus warehousing, plus cross-docking. The IC company relies to a large extent on the LSP's information systems and on the LSP's access to worldwide network of transportation assets and carriers (that are shared with other clients). The benefits are shorter cycle times, elimination of inventory stocking point, smoother new product introduction (discontinuance), and postponement of final packaging. The final



example is of manufacturing companies that are using small parcel/express delivery companies for both warehousing and delivery of spare parts, 4. *PartsBank*. This refers to a branded process that FedEx created a number of years ago. The activities include the same as international direct shipment added with warehousing. Typically spare parts are stocked by the LSP at a warehouse near its transportation hub. The LSP arranges for transportation (air or truck, next day or two day delivery) based on the delivery requirements of the manufacturer. The benefits are centralization of inventory, lower transportation cost, improved visibility of inventory, and smoother new product ramp, discontinuance. The physical and information assets are shared among many clients. Solution involves significant restructuring, including elimination of warehouse tiers, repositioning of inventory and associated changes in stocking policy.

### **3.2.4 The Transfer Service Matrix**

In the Transfer Service Matrix the demand (customer needs) of transfer services and the type of them is on the horizontal axis. On the left end of the axis is Special Transfer – a one of a kind transfer type. As is moved from left to the right along the axis the transfer needs are getting more common and uniform and at the same time the volume of them increases - on the right end are located transfers with high volumes. On the vertical axis are the types of transfer channels. On the top is the Adaptive Coalition –channel consisting of an organization or dedicated team with tailored transportation and handling equipment. As is moved downwards the set-up of the channel, and capabilities to supply transfer services are more general, and previously made preparations and the volume of organizational and technological resources involved in the channel increase. The latter meaning in practice that the more parties tend to be involved in the channels the closer to the Open Network in the bottom is moved.

The justification of the TSM is based on the observation that different kinds of transfers are performed with a type of transfer channel that somehow is able to cope with the transfer needs. Requirements for the transfer channel such as ability to adapt the physical dimensions of the goods, service scope, scheduling, geographical coverage, pricing etc. must be taken in account when a customer is selecting the best alternative. These aspects

put limits for the selection but they don't consider what the efficient means of transfer are. Although in practice the facts in the prevalent circumstances may distort ideal solution this cause a need to evaluate what would be the best match of transfer need and transfer channel in order to be efficient. One rule of efficiency in transfer services is: "It is most efficient to move in a continuous, straight line whenever possible. This rule describes the most efficient movement for goods. It calls for little or no circuitry and minimized stopping and restarting. Sporadic movement means energy loss, chances for delay and damage, and an overall increase in costs" (Coyle et al. 1994).

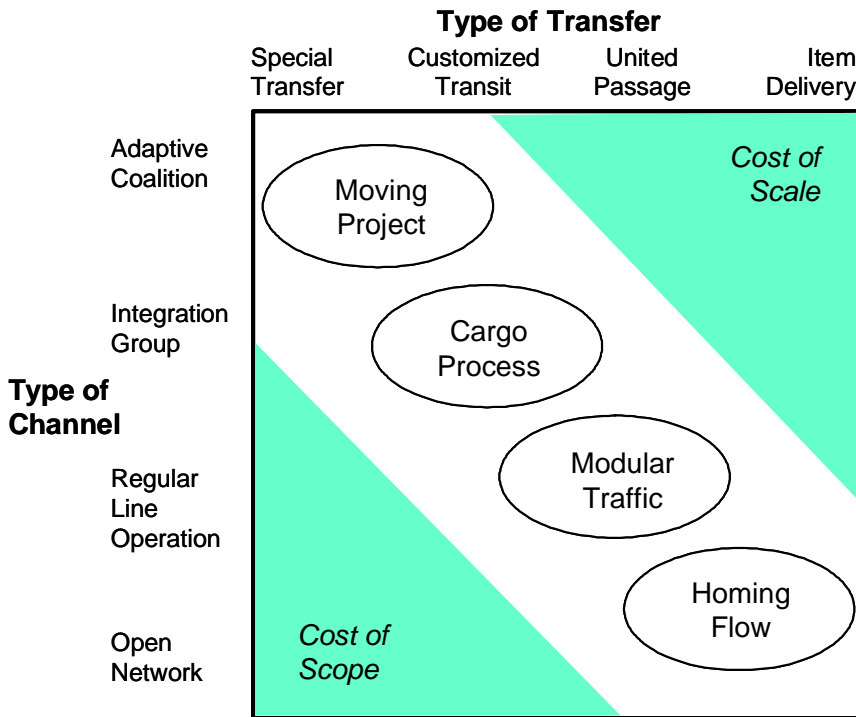
The continuous move requires volumes otherwise the investments required for systems (here channels) cannot be carried. On the other hand the operational expenses must maintain within reasonable limits. The right matches between the volumes (of the transfer tasks and the resources available) and both the absolute costs and the relative share of fixed and variable costs play a central role in defining the feasible solutions. These principles have been applied in the Transfer Service Matrix. The variable cost elements tend to dominate the supply side of the service production (channel) in the upper end of the vertical axis as they are by nature temporary arrangements. Establishing the channel types with more permanent elements in the lower end of the axis require higher investments and therefore fixed cost elements play a central role in these channels whereas the variable cost elements remain relatively low. As the volume of each type of transfer services grows from left to right along the horizontal axis, the influence to costs involved in the channel will change as well.

Transfer service solution i.e. transfer service is found where certain type of transfer need is (successfully or less successfully) satisfied through certain type of transfer channel. The solutions can be positioned in the TSM. Solutions located in the up-right corner of the matrix should be avoided for dedicated organization and tailored technological resources is too heavy arrangement for a simple anywhere, anytime transfer – with volume the operational expenses would explode (Cost of Scale). Correspondingly solutions in the down-left corner should be avoided. Establishing of networks that work for all kinds of transfers require huge investments. In the case of Special Transfer need there is no volume to carry the investments (Cost of Scope). In the TSM along the diagonal are the solutions that minimize the total costs (including e.g. costs for risk) per

transfer task. The higher the volume of the transfer needs the better the investments of the more permanent channel types are utilized and the lower the fixed costs per transfer transaction are. Therefore as the variable costs are already relatively low a cost minimum can be achieved along the diagonal on the down-right corner. Equally a unique transfer task can be performed efficiently using a channel of dedicated team with tailored resources as the fixed costs are minimized. However, the variable costs are high and therefore if the transfer volumes of similar tasks are increasing a channel type with shared resources should be used instead. There are thus efficient combinations of needs and channels, and an area - along the diagonal - where efficient transfer service solutions, so called generic transfer services are found. To be noticed is that the transfer service solution is in many cases actually a portfolio of different tasks and stages forming the transfer service entity fulfilling the requirements.

### **3.2.5 The Generic Transfer Service Solutions**

The generic transfer service solutions are positioned in the matrix (Figure 3-2) to represent the four efficient combinations of transfer needs and transfer channels.



**Figure 3-2** The generic transfer service solutions

The nomination is based on the most dominating feature of each solution. In the following these transfer solutions and the basic features of them are described.

**Moving Project** - one of a kind transfer (e.g. large pressure vessel transferred in one piece). It makes no sense to establish permanent transfer systems for transfer of products whose configuration and properties, physical dimensions and geographically distributed demand is previously unknown. On the contrary such transfer is designed according to the special (even unique) requirements. The features of a Moving Project are a combination of Special Transfer type on the demand side and Adaptive Coalition channel type on the supply side. A Moving Project may include special transport equipment, tailor-made support structures to hold the cargo and probably exceptional route due to road/channel etc. restrictions scheduled according to the need to the dedicated destination. In case of current production the organization carrying out the Moving Project in the first transfer stages may be the manufacturer of the product. The reason is that special handling capabilities are required in the manufacturing anyways and the

manufacturer may take the transferability in account already in the design phase. Depending on the other requirements a temporary coalition with the required skills and capabilities will probably take place on the most other transfer stages.

**Cargo Process** - the transfer of goods with low separate volumes (e.g. during the truck collection) or products to be reconfigured (e.g. PC's). The existing transportation infrastructure, equipment and activities can be shared and combined together to form customized transfer processes. The network of third parties utilizes transfer service offering over the organizational limits. Additionally for the physical dimensions of the goods or handling requirements of the transfer are not necessarily specific (although may be dedicated) also a variety of technological resources can be used. The resulting benefits are flexible allocation and higher utilization of the capacities. The value-adding services like repacking, labeling and other tailoring can be done if the shipment is temporarily stopped during the transfer. Otherwise the route can be adjusted or selected flexibly according to the requirements within the schedules available to the final destination. Goods that in principle belong to this category but can be combined and unitized together to form higher volumes, can at least part of the transfer portfolio utilize the more standardized (and likely more efficient) method of Modular Traffic.

**Modular Traffic** - the transfer of products unitized to represent significant volumes with standardized connectivity (e.g. transfer of intermodal cargoes). Modular Traffic utilizes terminal and operator network of the Regular Line Operator –channel with their technological and organizational resources for the transfer of unitized cargoes (standard size of packages like pallets, platforms and containers) from a stage or an organization to another. The transfer in such a case is a collection of transfer activities that are linked together in order to create functioning activity chains. Connectivity in the interfaces (e.g. in terminals) between transfer functions and ability to switch to another transfer mode plays significant role. Therefore at least some kind of standardization of operations, transportation machinery and equipment, and handling of information is a necessity. A transfer service entity of Modular Traffic can be seen as a portfolio of modules of transfer stages. The scheduling is based (mainly) on fixed timetables that enable high utilization rates of the key resources by accumulating volumes in order to achieve

economies of scale. Frequency of transport in main legs and estimation on delivery time is offered but allow also repacking during the transfer.

**Homing Flow** – a simple transfer activity with high volumes (e.g. transfer of letters or courier services are close to that, although it is difficult find services today in practice that corresponds the description). Products that are uniform and probably also small enough to allow simple transfer and handling in mass volumes doesn't necessary need specification of anything else than the final destination to be transferred. The Homing Flow is not tied to specific locations or schedules - but in order to be efficient the transfer service is produced using resources that allow continuous transfer within a previously known delivery time frame. As the material to be transferred is uniform and if at the same time the overall demand of it is stable (equals to stable transfer demand), it is possible to create integrated transfer production system to support continuous material flow. It is however not likely that in a wider geographic area the demand is stable. Therefore a network open for every party to join to produce services without preliminary agreement will allocate the resources more efficiently to meet the transfer needs. Participation however involves adoption of certain defined standard protocols for high connectivity, which allows also a variety of technologies with high connectivity and thus resulting in a wide geographical coverage (service available anywhere). Market mechanism guides - with the aid of intelligent agent technologies for example - the scheduling and routing through this network and is the principle for allocating the resources. Therefore the service offers a lot of alternative connections and opportunities for automatic routing. The service delivery performance and delivery time estimation is highly based on probabilities (service available anytime).

### **3.3 Utilization of the Transfer Service Model**

The Transfer Services Matrix can be used for different kinds of analyses in different aggregation levels although it was originally created particularly for conceptual level analyses of transfer services. The analysis may begin by positioning of the current conceptual level transfer practices/services in the matrix according to their characteristics in both the horizontal and vertical axis. The analysis could then continue for example with a more detailed level investigation where the transfer service concepts (as they are

typically transfer portfolios) with several transfer stages are split in the matrix. The first part of the analysis with a transfer portfolio represented as an entity gives a general status of the transfer service in question whereas in the latter stage sources for practical improvements may be found more easily.

Positioning in the matrix is also a starting point for analyzing the past and outlining the future of transfer services. If the past services are positioned and compared with their current counterparts, the changes are presumably clear - it may be found that the service offering today in general is more diverged and the service elements better formed in order to be efficient. It may also appear that the developments have not led continuously to a certain direction, but stepwise changes have taken place. This also shows that it is not possible to forecast the future simply based on past trends, but such an analysis may help to understand the reasoning behind and thus figuring out the future scenarios in transfer service needs and solutions.

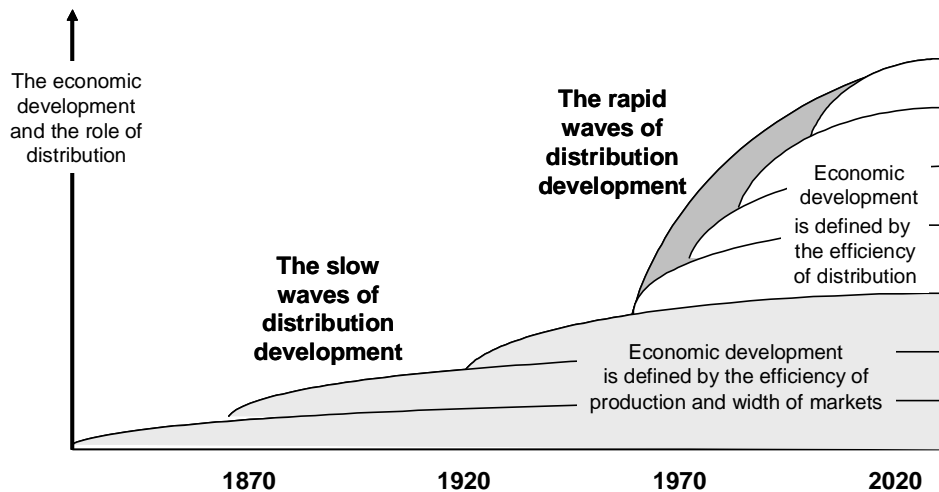
The transfer service solutions are positioned in the matrix using classification based on the features of the service needs, goods to be transferred etc., and the elements of the transfer channel respectively. However a theoretically more exact aid to position the service solutions in the matrix could be based on costs. The in depth analysis and development of the (efficient) service offering should be linked with the investigation of costs and the attributes that influence to the distribution of the costs.

## 4 Development of Container Transportation within Physical Distribution

The development in economy and physical distribution are interlinked. Further the changes in transportation and cargo handling solutions have reflected the development stages in physical distribution.

### 4.1 Development Phases of Physical Distribution

According to Haapanen and Vepsäläinen (1999) in different times distribution has had different role in relation to the general development of economies (Figure 4-1). The slow approximately 50 years long development stages of the economy have based on the more effective production and the expansion of the markets, where distribution has had a supportive role. The rapid 15 to 20 years long development stages of the economy began after the Second World War. Distribution together with the development of its' technical systems and service offering has become the source of transformation of the economy.



**Figure 4-1** The Development Stages of Distribution – the Slow and Rapid Waves of Development (Haapanen and Vepsäläinen 1999)

Haapanen and Vepsäläinen (1999) further address that the role of the distribution has changed either smoothly or impulsively within the slow development stages of the economy. These slow development stages are:

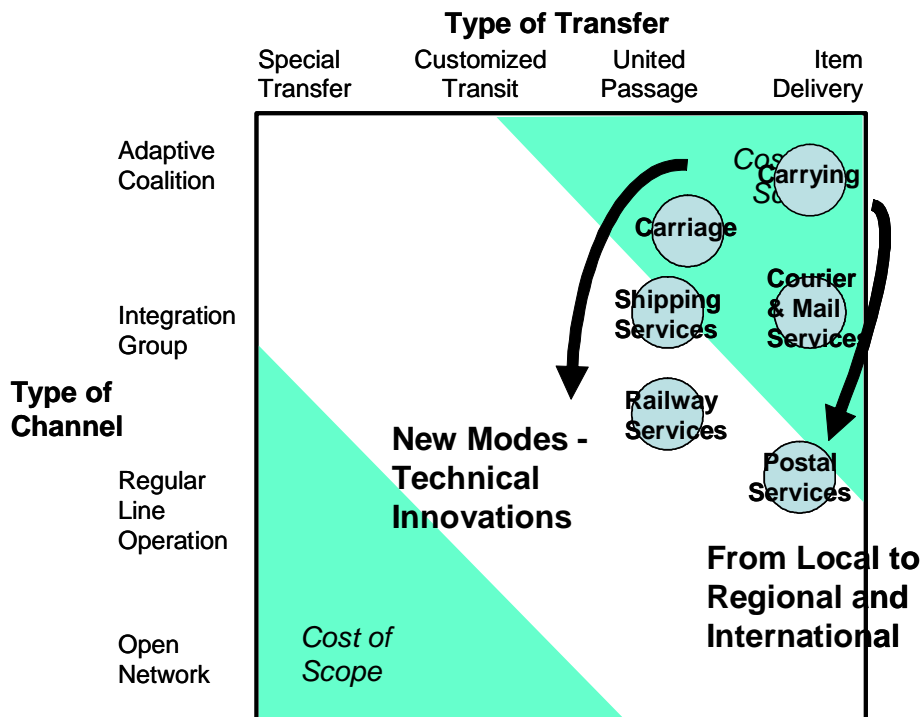


- Self-sufficiency economy and pre-industrial development stage before year 1870.
- Production driven economy during 1870-1920. The development of distribution enabled mass production.
- Demand driven economy during 1920-1970. The distribution served the internationalization of the production and markets.
- Distribution driven economy during 1970-2020. The challenge is to intensify distribution and customer service in order to spread wealthy.

#### **4.1.1 Self-sufficiency Economy and Pre-Industrial Development Stage**

In the self-sufficiency economy the activities were local and driven by necessary needs of daily living. The housing and tools were self-made and the positioning of population was defined by fishing, hunting and later by cultivation opportunities (Haapanen and Vepsäläinen 1999). In the early ages before any organized societies were established, people carried the goods themselves (Figure 4-2). This seemed to satisfy most of the needs in the self-sufficiency (or collecting) economy for majority of the transfer needs were local short-distance moves of relatively small items. Lack of equipment for transfer of heavy objects over longer distances may have hindered the development of the societies. Later capturing of animals (e.g. horse, ox and elephants) to serve as power sources enabled the human to expand the living setting and to move and transfer heavier cargoes. These together with the capability to utilize waterways led already in early times to even some international trade (proved by the object findings from the Stone Age). The general setting of the transfers however clearly remained local.

When agriculture was invented, the societies began to formulate and grow. Followed by that the technical development was accelerated and inventions (like carriages) took place also in the transfer techniques (Figure 4-2). Later the growing population that forced people to search sparsely populated areas to colonize may have accelerated technical inventions - wagons for example played a role in the settlement of North America by Europeans. The transfer needs were still mostly satisfied “in-house”.



**Figure 4-2** Early Developments of Transfer Services

The period from the 1820's on is called pre-industrial era. According to Haapanen and Vepsäläinen (1999) the activities were mostly based on self-sufficiency economy but the local trade was growing and began to expand to nearby villages and towns. Companies were still small, but the goods production began to differentiate and the degree of working up rose. The new modes of transportation seem to appear at the same time as the organized societies started to formulate – these required increased systematization and accumulation of volumes. This led in higher efficiency of the transfer solutions. The inventions in transportation technique supported also the internationalization of the trade. Steam ship for example was invented in the early 1800s. Due to the shipping, towns along ports grew and in 1840 regular shipping between Europe and North America began. On the other hand the inland channels that were constructed in U.S. for barge operation were outstripped by railroad (Muller 1989). Railroad together with a new invention, telegraph created the prerequisites for more efficient distribution already before the production had developed to that stage (Haapanen and Vepsäläinen 1999).

According to Muller (1989) it was common in the 1700s that goods were transferred between modes using primitive methods. However one early system in common use antedated the modern ro-ro operation - horse-driven vehicles were rolled on and off waterborne units when ferries, rafts and barges were used to cross harbors, lakes and rivers. Many of the intermodal improvements grew from the U.S. barge canal operation that consisted of land and water portions in the journey. Barges that carried a mixed load of passengers and cargo operated as intermodal containers as they moved overland between canals aboard horse-drawn wagons, railroads or cable railways.

#### **4.1.2 Production Driven Economy**

The industrial revolution since 1870 began when industrial companies started serial production and production lines were established. Together with the production technology innovations also new organizational modes appeared (hierarchy) in order to manage the growing resources required. However the parts were still made manually until Henry Ford in the early 1910s developed standard parts and the real mass production began (Haapanen and Vepsäläinen 1999).

The production driven economy was possible for railway, steamship, telegraph and postal services were developed already and allowed efficient distribution of the products. It was possible to concentrate the production and to sell the products to even distant markets. Printed media also benefited from the development and newspapers with advertisements created the mass marketing. The channels for trade developed – department stores, mail order business and chain stores were established (Haapanen and Vepsäläinen 1999). The trade and distribution were predominantly regional.

Railroads dominated the U.S. freight transportation from the mid-1800s until the 1920s. Railroad freight service was station-to-station where freight shippers and receivers were responsible for delivery to and pick-up from rail stations. Also containers were used in this traffic for improving less-than-carload (LCL) service. In the late 1800s unit trains were introduced to haul bulk commodities such as grain, coal and other ores but - as is typical for transporting bulk commodities in general - were designed to avoid intermodal transfer. For example in a unit train transporting coal the car units were moved as a steady pace from mine origin to final destination (Muller 1989).

Although the service in the railway can be classified as United Passage –type (Figure 4-2) it represented either one transportation stage in the transfer portfolio or was singlemodal instead of intermodal. In the latter case of unit trains the transfer needs were satisfied with a single leg of transportation. This was possible for there was a broad network of railroads for long-distance regional coverage (Muller 1989).

#### **4.1.3 Demand Driven Economy**

The mass production that began in the 1920s required the markets to be expanded and demand for the production intensified. The production technology was developing and made differentiation of standard products according to customer segments possible. Subcontracting was increased and the network of factories expanded to several countries. The marketing internationalized and new hierarchy levels were established - goods were delivered through multi-level distribution channels and warehouses were in all geographical areas. At the same time the organization of the information flows related to sourcing and selling was realized. These two channels, the activities related to physical distribution and storage and the activities related to sales and supporting information flow, were separated from each other (Haapanen and Vepsäläinen 1999).

The technological developments in the physical transfer and distribution influenced to location of production and subcontracting. The most important step in sea transportation was the invention of marine engines in the 1910s. The freight carrier service became more regular and reliable with increase in speed (Haapanen and Vepsäläinen 1999). Another remarkable step was the development of trucking since World War I where trucks proved their capability and versatility to move troops and goods. World War II reemphasized the importance of trucking as an integral part of the (e.g. U.S.) transportation system (Muller 1989). Air traffic began to expand also after WW II and monetary system developed enabling e.g. more efficient money transfers. During the period speed began to be seen as an important economic factor. Companies began to combine different modes of transportation, and unitized transportation containers and cargo platforms were developed (Haapanen and Vepsäläinen 1999).

After World War I a number of railroads developed less-than-carload/container load (LCL) service. However only some of the railroads used containers as intermodal units in

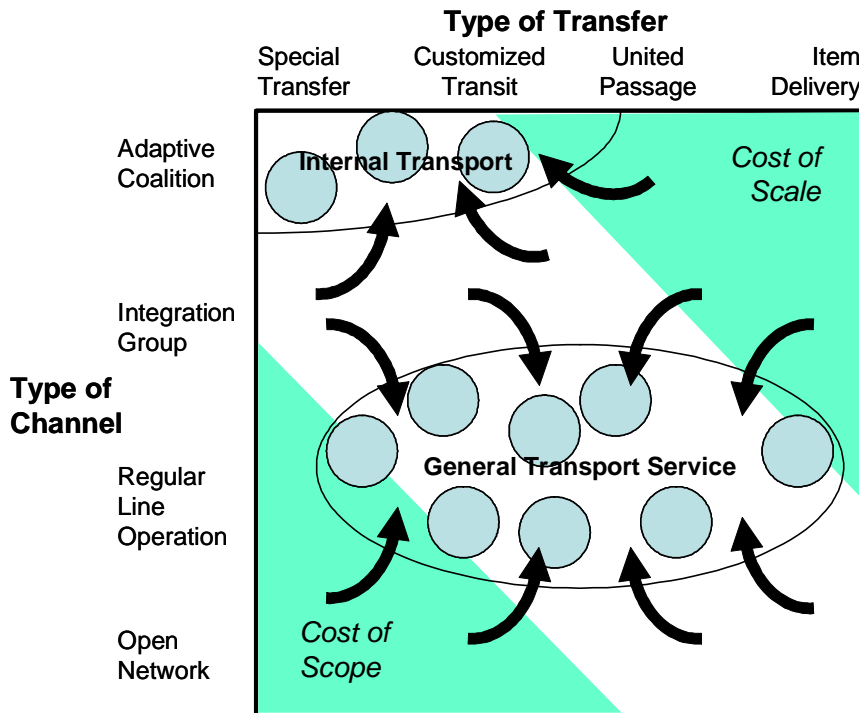
conjunction with truck pick-up and delivery whereas some provided only added security for their shippers using containers. The first recorded carriage of freight by intermodal truck trailers on railroad flatcars occurred in 1926 on the Chicago North Shore and Milwaukee Railroad. The piggyback services grew slowly (it was hampered by growing rail-truck competition and inflexible U.S. government regulations) but steadily until the mid-1950s when the pace quickened (relaxation of regulatory restraints started). In 1929 Seatrain Lines Inc. introduced a new intermodal system that loaded and unloaded full railcars on specially built seagoing vessels (The Port of New York Magazine 1932). The two vessels in the intermodal service between New York and Havana were the fastest freighters on the oceans at the time each with the capacity of 100 loaded freight cars. At each port, special terminal facilities were constructed to connect with trunk railroads and using specially designed heavylift cranes. A vessel could load and unload in 10 hours the same amount of cargo that took nearly six days for traditional cargo-handling system. The ships also required investments to equipment - cradled elevators that were lowered down hatches carrying the cars, stopping at four different decks where the railcars were shunted onto tracks (Muller 1999).

Surprisingly the land-sea interchange was one of the last to receive the benefits of containerization for intermodal movement of cargo. Like in the early days of railroads, ocean shipping companies used small, nonstandard containers to consolidate and protect shipments. Containerization of ocean cargo for intermodal purposes was not widely practiced until the 1956 "container revolution". It took quite a few years - Transatlantic containership operation started in 1966 - before intermodal containers were used in all ocean routes. In the mid-1960s, as rail intermodal freight transportation spread across the nation, the concept of using the continental U.S. as a landbridge for containers moving between the Pacific and Atlantic oceans began to develop. A rail system was developed to carry containers on rail in competition with the all-water route via Panama Canal. This concept offered railroads a new competitive service for both international and domestic origin, including destination container movements. At the same time many of the new containership decision makers were coming from the trucking industry. They were not accustomed to working with the railroads, unlike between ocean carriers and railroads where working relationship began to develop (Muller 1989, Muller 1999).

#### **4.1.4 Distribution Driven Economy**

In this current era of services, business is ever more developed based on the conditions given by distribution if only the demand is adequate. Production is in principle possible to arrange in any case. The global demand is directed by the price of goods or services delivered to the final destination. In many cases over half of the price can be due to expenses of physical transfer/distribution. These elements have begun to limit the sales and production of goods. Therefore a growing discussion of services, efficiency of supply chain and value added for customer has taken place (Haapanen and Vepsäläinen 1999). Since the early 1970's more holistic approaches to customer services gradually found ground. In order to supply entire service for the customers it has been common to offer a wide variety of transfer services through a single channel. This is so called general service. At the same time significant portion of the services was still produced in-house by the manufacturing industry or parties involved in trade (Figure 4-3).

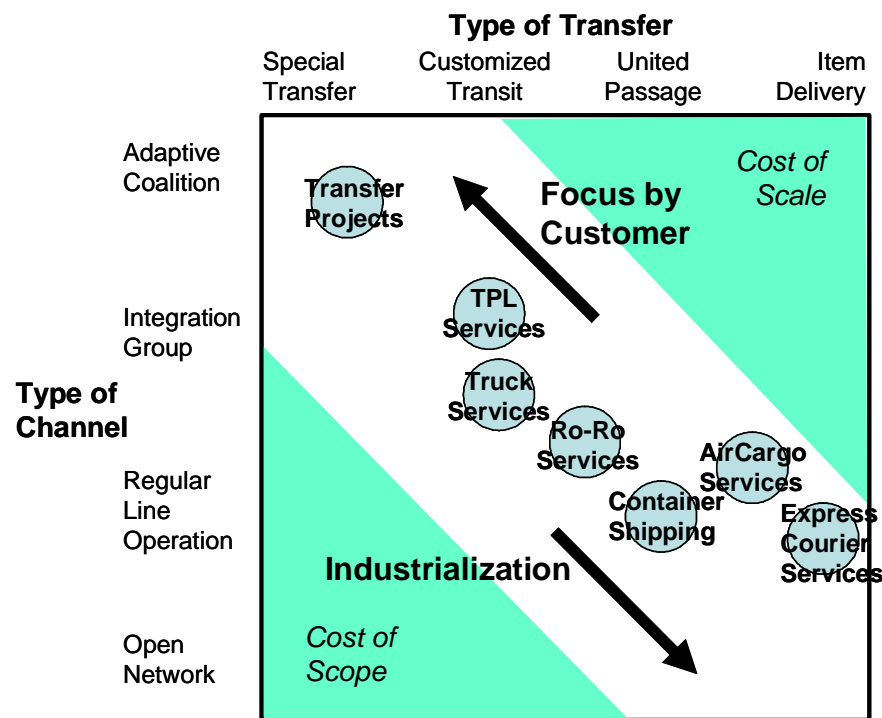
This development was proved less efficient however; therefore services are again taking more diversified forms. In replacing the general service in transfer services we may outline rapid waves of distribution development; integration of services over transfer phases for efficient service offering, followed by increased connectivity between phases for flexible formulation of services. The in-house service production respectively will transform to respond wider customer base with specific needs.



**Figure 4-3** Previous Polarization of Transfer Services

Due to economies of scale and standardization the solutions closer to the lower right hand corner of the matrix are getting cost wise, and probably also service level wise (service frequency, geographical coverage etc.) relatively more attractive. In order to increase productivity, investments are made in mechanization and automation to reduce manual work. In transfer services technological development and IT are boosting productivity. Besides organizational changes this is likely to result in increased automation. Downwards the vertical axis the volume of resources (technological, human etc.) involved in the channel increase, therefore the total costs grow. The costs structure changes however - variable costs are transformed to fixed costs and cost per transaction is reduced. Opposite to this is a growing trend to focus on customer. The service providers develop capabilities to offer customer dedicated services. In order to efficiently offer such services, organizational issues and related innovations have got more weight.

The new types of organizations like are likely to find positions where special capabilities need to be constructed even temporarily. In the matrix these are in the upper half of the vertical axis with corresponding channel types. There are already specialized TPL (Third-Party-Logistics) companies providing services to the logistics needs of trade and industry. This is part of the general trend to concentrate to core competencies and outsource other activities. Intermodal services involve organizational innovation element to cross the interorganizational boundaries. In this development IT, standardization, and unitization of physical transportation (ISO containers and cargo handling technologies, Ro-Ro handling with cassette systems etc.) are involved. The required cost efficiency (in volume market) and time efficiency (for valuable items) and on the other hand increased customer specific needs, have resulted in either industrialized services (intermodal or express courier services) or customer driven approaches (like project type services) in the service offering (Figure 4-4).



**Figure 4-4** Lately Inventions and Drivers in Transfer Services



The companies have got more opportunities in the global markets as the regional regulation has been demolished. Simultaneously advancing technology in transportation and related cargo handling and in information transfer (telegraph, telephone, telex, telefax, and internet) has developed production and distribution capabilities. This has increased efficiency in physical goods transfer. The simultaneous specialization in service production helps to provide diversified service entities according to customer requirements. Differentiated structures are established to facilitate physical goods flow, sales, ordering, and payment and securities (Haapanen and Vepsäläinen 1999).

## **4.2 Illustration of the Future Physical Transfer Services**

Several of the development trends in transfer services discussed in this dissertation was addressed already ten years ago by Coyle et al. (1994) (Table 4-1). Today however word 'global' would be used instead of 'international' to describe similar phenomenon. Among them is also diversification of services expressed in other words or the increasing networking. Implied are also the significance of customer demand and more generally the role of market driven services. Today it would be said that production based push strategies are increasingly replaced with market pull.

Some developments that today are believed to have potential - especially technological - however were not perceived. These include mobile communication and tracking and tracing solutions. Other than that the trends by Coyle et al. are in line with the assumptions made of the future developments relevant to the axis of the Transfer Service Matrix. Relevant to the type of transfer –axis it is mentioned the shift from heavy industrial to service-demanding finished goods transportation. Similarly concerning the type of channel –axis they say that decision-making and accountability is pushed lower in the organization which can be interpreted to mean trend towards more open services networks.

**Table 4-1**      Transportation Trends (Coyle et al. 1994)

<b>The Transportation Market</b>
<ul style="list-style-type: none"> <li>Tailoring of services and equipment for specific shipper/receiver needs</li> <li>Freight transportation provided for just-in-time, sequenced movements</li> <li>User cost for international transportation declining</li> <li>International transaction easier</li> <li>Sale of transportation service being done more by parties other than the sales and marketing group of the carriers</li> <li>Shift from heavy industrial, production-oriented transportation to fast, service-demanding finished goods transportation</li> <li>Users of transportation are seeing transportation less as a distinct operation and more in the context of total production, overhead, sourcing, labor, distribution, and marketing factors</li> <li>Greater marketing orientation by carriers</li> <li>More travel</li> <li>More discretionary travel</li> <li>More international transportation</li> </ul>
<b>Transportation Supply</b>
<ul style="list-style-type: none"> <li>Increase use of third-party services</li> <li>Consolidation in air, rail, and motor modes</li> <li>Integration of modes via joint ownership or special arrangements</li> <li>Strength and health of feeder firms (commuters, regional motor carriers)</li> <li>Continued technological advances in most modes</li> <li>Less private carriage use for reasons of cost savings; still present where special services are involved</li> <li>More international alliances of carrier</li> </ul>
<b>Operations and Management</b>
<ul style="list-style-type: none"> <li>Operations in closer link with marketing and sales of the carrier</li> <li>Leasing of containers, aircraft, terminal facilities, and other assets on increase</li> <li>Information-driven organization and structures</li> <li>Decision making and accountability being pushed lower in the organization</li> <li>More substitution of communication of transportation</li> </ul>
<b>Government Policies and Regulation</b>
<ul style="list-style-type: none"> <li>Deregulation spreading from United States to Canada and Europe</li> <li>Less economic regulation (rates, routes, services, finance)</li> <li>Increased noneconomic regulation (environmental, substance abuse, safety)</li> <li>Government funding not keeping up with deterioration of transportation infrastructure</li> </ul>

#### 4.2.1 The Era of New Focus?

The 20th century with a multitude of technological innovations, was development of the internal capabilities and efficiency of individual transport modes. The reverse side is however that in many supply chains one mode of transport has dominated whereas the others have adjusted to that. In deep-sea shipping for example the ever larger ships sizes with growing cargo handling requirements reflects domination of a single mode. There are also signs of interest to maintain the power positions achieved with e.g. horizontal

mergers in the industry. This is alluded to also by Coyle et al. (1994) with “consolidation of air, rail and motor modes”. A somewhat opposite development they also speak about “integration of modes via joint ownerships or special arrangement” could open avenues to establishing of so called “Mega-Carriers”.

Compared to previous decades with different views in production, transportation and storage (and marketing and sales) to goods delivery, a more holistic approach has taken place in industry and trade. From the goods supplier point of view this would ideally mean continuous processes throughout the physical transfer chain without any stops and need for storing between in order to minimize capital tied in the process. On the other hand due to the fact that the customer demand and needs are increasingly driving the development, the supply has turned into more easily available, versatile and diversified services that are delivered through developing channels. Due to the ongoing globalization and international division of labor the transfer services need to cover wider geographical area. The trend for smaller transportation batches has encouraged to increasingly unitizing of bulk cargoes. As a result transfer volumes in general are increasing and relatively even more the more harmonized needs are in question. In order to respond to such transfer needs with efficiency, the transfer service solutions supposed to be more commoditized according to segmentation of different customer requirements. The ongoing trends seem to both increase the divergence of transfer needs and the transfer service solutions offering but at the same time strengthen the relative position of more networked and volume based services.

The challenges faced are reflected for example in the widespread use of “just in time” logistics (JIT) where shipments are getting smaller, more urgent and require accuracy in timing of the delivery whereas on the supply side the scale economies would require high volumes. These sometimes conflicting targets can be currently seen in shipping. At the same time when the volumes are split into smaller batches to be coordinated, handled and scheduled, in order to have more continuous cargo flows, concentration of traffic volumes into few ports is required to allow frequent visits of ships and efficient cargo handling through scale effects. Conflicts are created in the port because of with the same mechanisms it should be possible to handle large continuous flows of cargoes and flexibly adapt their separated time schedules and possibly special handling requirements.

The scale effects are also behind the continuous growth of ship sizes and thus reduced slot prices that increase pressures in port operations and land transport. Could we see an era where different transport modes are developed in a better mutual understanding - and thus achieve ever more functioning entities?

The above should translate into intensified cargo flow through the supply chain. In principle in the current service economy and information society more versatile and balanced physical distribution systems can be created. With the help of information systems transactions or outsourced individual services can be linked and coordinated. The technological development also enables to accomplish transfer needs (e.g. track and trace of deliveries) that were not possible before. As a drawback some investments increase stiffness of the structure and reduce the ability to respond to fluctuations in the markets. In that case the business risks are growing and potentially reduce the opportunities to adapt more advanced technologies in a later stage. This may also offer opportunities for more flexible competitors to enter the market.

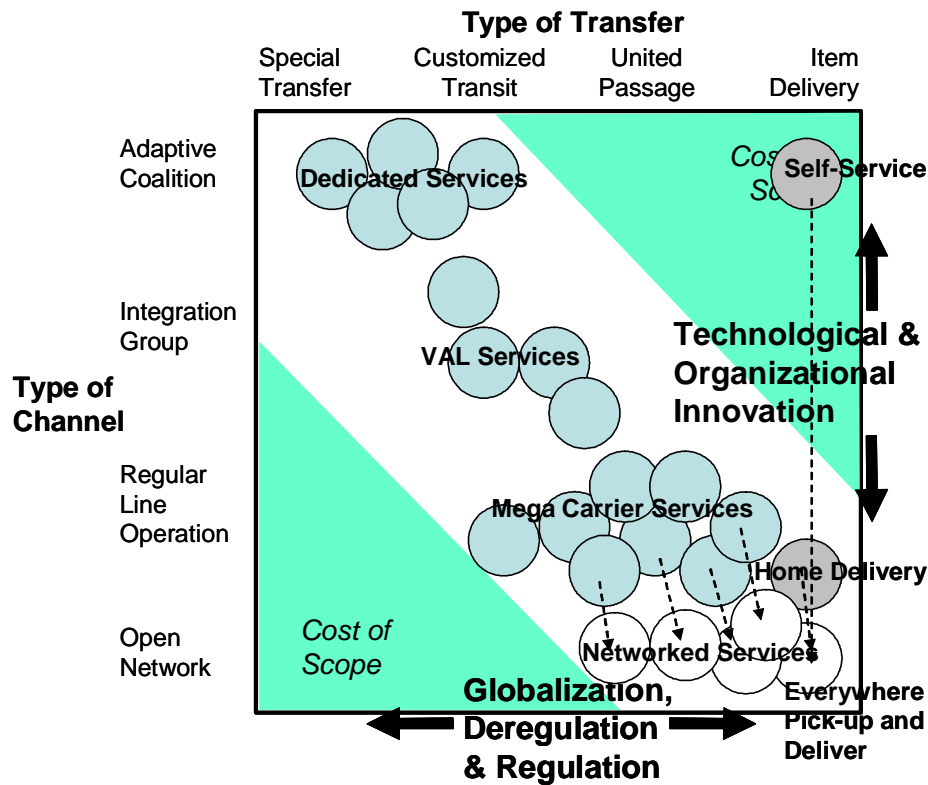
According to Kumar and Hoffmann (2002) in the literature is missing a more thorough consideration of the mutual relationship between trade volumes, transport costs and quality of transport services. The presented Transfer Service Matrix (TSM) connects the volumes in horizontal axis, costs in vertical axis and quality in terms of service characters in the services offered to the customer on the diagonal. The reasoning of the analyses conducted with the TSM is supported also by preliminary results of an on-going research (the Transport of the United Nations Economic Commission for Latin America and the Caribbean, ECLAC is analyzing trade flows between 15 exporting Latin American countries into six importing Latin American countries, where the correlation between trade flows, modal split, and transport costs were analyzed) that Kumar and Hoffmann mention. This research shows some interesting regression results: More expensive goods require higher transport and insurance costs; Moving a higher volume reduces transport costs thanks to economies of scale; A longer distance obviously increases transport costs, albeit by far not with a linear relationship; "More services" are closely related to the transport system's overall economies of scale and may also be an indicator of the intensity of competition; When shipping competes with land transport, maritime transport costs tend to be slightly lower (4.2%), which may reflect competition from

truckers, and also the fact that goods that are particularly difficult to handle by waterborne transport are taken onto trucks; Advances in port privatization do reduce transport costs. Not only may ports operate less expensively, but above all reduced waiting times and risk also lead to lower shipping freight rates; If exports exceed imports, the latter tend to be less expensive because empty transport capacity is required for the exports; and Higher speed implies fewer stopovers and thus possibly loss of business opportunities, plus additional fuel consumption.

The above results support the common understanding of the phenomena in trade. They can be pretend as forces that work up the transfer services but are also indications of the dynamics involved in trade flows. The market mechanism is found to support efficiency also in that particular study and in the light of the results the authors of that study strongly suggest that transport costs are not taken as fixed or exogenous in trade analysis. There is one somewhat confusing result that speed implies fewer stopovers which possibly leads to lost business opportunities. This is as a general phenomenon known in liner shipping when compared to tramp traffic or even liner shipping operators that don't have closing time and are therefore able to accommodate cargo until the last minute. However on the other hand this finding spurs on the clever diversification of services for if organized efficiently the business opportunities can be ensured with extensive collection/distribution network that supports the fast and efficient main legs of transport and vice versa.

According to Muller (1999) the forces of change influence the direction and rate of change in which transportation industry in general moves. These forces fit together with the Transfer Service Matrix. The globalization/trading patterns define the same on-going development that is shown along the horizontal axis of the TSM where the volumes grow when moved to the right (Figure 4-5). Similarly the new and emerging technologies shown in his model take place in the vertical axis of the TSM. In the Transfer Service Matrix however also the organizational innovations besides technological innovations have been applied (as a source of enhanced structures supporting the service supply). The deregulation again is likely to boosts globalization development for the barriers of trade are diminished. History has shown that deregulation supports technological innovativeness (and probably organizational innovativeness). As a result more manifold

and diversified service solutions are to be expected to arise. Muller's views that the new and emerging technologies have an influence on cost, globalization /trading patterns have impact on customer price (related to volume in the TSM) and deregulation/regulation have on impact to the services make sense. The similar phenomena are considered in the Transfer Service Matrix.



**Figure 4-5** Forces Influencing to Transfer Services - and Illustrated Results

There are also a variety of concrete developments that are to shape the future services. These include e.g. increased customer requirements and demand segmentation, service specialization and diversification, channel separation, support of information technology, and increased connectivity and modularization. Networked service entities with quicker reaction to changing demand, wider variety of routing and scheduling, and better opportunities to serve customers globally, could also attract more demanding customer.

Also new types of organizations are likely to appear. One potential future consequence is the partial return of polarization in the service offering.

The assumption of partial polarization is based on the customer needs of efficiently produced low costs services on the one hand, but simultaneously specific services required on the other hand. The increased efficiency requirements and more transparent market information due to globalization and reduced regulation suppose end-to-end solutions where less time is left for operations in between and for postponement. The varieties of customer specific and novel services are enabled with the innovative and more flexible technologies, and are produced with temporary organizational settings. The services between are the in relative significance weaker turning VAL services (Value-Adding Logistics) currently provided by 3PL's and 4PL's. They are likely to partially merge with Mega Carrier services that have been predicted to appear in the business. Mega carrier service is offered by a single party that has established a closed network with global coverage of wide set of transfer services. Mega Carriers would mean a certain kind of step backwards to a time just a decade or two ago when organizations producing general services were in strong position. This time however the scale benefits are so powerful within the network that they may support such structure. The relationship between cost and volume is going to change so that services like the VAL services are potentially increasingly in-sourced by Mega Carriers. Also although the services provided in Regular Line Operation –channel benefit from innovations and e.g. the increasing standardization and connectivity between the transfer phases, the benefits are likely to be weaker than those provided in other channels. As illustrated in the Figure however that structure is challenged again if the Open Network –channel can be introduced in practice. The argument and justification of development efforts in terms of new adaptability is that the relative growth of costs despite more extensive services decreases. In this new order it is likely that some services offered in the Regular Line Operation –channel will continue to efficiently take care of transfers of relatively stable high volume goods flows as parts of this new network. The distribution deliveries with lower predictability however will be included and probably be dealt with a market driven mechanism formulated out of different sizes of service organizations.

#### **4.2.2 The “Sweet Spot of Change”**

The transfer needs of low predictability equals to cost and service wise difficult challenge of more efficient matching with the capabilities. In case of highly fluctuating consumer transfer needs, increasing self-service has been used to avoid some of the consequences – like with the “first mile” and “last mile” problem. Letting customer deliver the goods to the collection point to accumulate the volume or pick up from the delivery point (e.g. retail shop, post office), service provider eliminates the costly transactions that are also challenging to forecast. The customers may purchase even some of the devices (like a car) required for the self-service. There is an analogy in the mobile telecom services where service providers offer the more infrastructure type of technologies and customers increasingly purchase the technological devices required.

According to Tompkins (2001) home delivery is often referred to as the “last mile” in the supply chain. In recent years, this has gained more notoriety due to the established Internet-based home delivery as a variety of companies are delivering home products such as electronics, furniture and groceries. The need has been there however for a longer time. In the early 1900s it was fairly common for the town grocer to deliver groceries to the home by horse and carriage and to accept orders on credit. In the late 1960s the proliferation of supermarkets caused the virtual elimination of home grocery delivery. It was not until the dot-com revolution that home grocery delivery became popular again. Challenges are manifold - a broad selection of product at competitive prices should be offered and to be delivered within a specified delivery window; and the products must be as fresh as or fresher than in the local supermarket and arrive in good condition. In order to cope with that internet grocers rely upon software programs that optimize delivery routes, keeping in mind the shortest delivery path while considering the numerous delivery time commitments. The programs are constantly churning data to determine if and when capacity in a particular neighborhood has been reached. Also the amount of times that product has to be handled is important in the considerations. On the other hand most Internet grocers realize that the human side is critical to the success of their business. The only human contact the consumer has with the company is through the delivery representative. Finally the customers must be asked to pay for the services they desire (Tompkins 2001).



The above transfer services can be routinely offered by service providers with the illustrated Open Network, no guarantees of the human contact tough. In the future with flexible technology, innovative service organizations and high connectivity of transfer phases it may replace a lot of the requirement for self-service. This requires that the total costs per transfer task are reduced due to e.g. more efficient allocation of capacity. The need of transfer service of an individual consumer is highly difficult to predict for a lot of the intentions of an individual are random. This means that although consolidated demand of a geographic area is known the exact distribution of demand in a certain moment of time is not previously known. Therefore as the needs in the most detailed level fluctuate, efficiency would require responsively fluctuating supply. The solution is shown in the Figure 4-5 where after the introduction of Open Network –channel previous Self-Service and Home Delivery services are merged to formulate something that is called Everywhere Pick-up and Deliver Services. This would mean that the existing transfer resources are continuously allocated in-move according to the updated demand patterns based on the on-line information of the end customers' needs.

Networked environment offers more opportunities than hierarchies for combining of new ideas. As the global innovations are getting more mature in the life cycle they tend to spread downwards along the diagonal of the TSM. Therefore they become properties of the network to form a wide variety of service capabilities. The lower right corner of the matrix is likely to face the most revolutionary developments in transfer services thus becoming the “Sweet Spot of Change”. In the future a lot of the service needs can be satisfied with the expanding capabilities of the networked services. Similar development is going on in telecom sector where IP-based networks have increasing capabilities to mediate different kinds of services that previously were considered customized. It looks however that none of the current channel approaches with the service offering is going to completely disappear but their relative significance will change. In order to satisfy the less common customer needs for example, customer driven solutions with the corresponding channel arrangements are still required.

Lee and Whang (2001) ascertain that a few companies have come up with innovative ways to apply order-fulfillment strategies and that the secret lies in making good use of information and leveraging existing resources to coordinate order-fulfillment activities. In

order to do that more-accurate, up-to-date information on customer demands can allow products to be delivered in the most direct way, thereby lowering cost and improving efficiency. For different kinds of products and environments they suggest five innovative strategies to e-fulfillment strategies; logistics postponement, dematerialization, resource exchange, leveraged shipments and the clicks-and-mortar model. According to them smart companies take the demand information that supply chains capture and use it to assemble or allocate final goods on demand, improving efficiency by shipping products to the final destination with fewer intervening stages. They call the strategy logistics postponement - the company postpones delivery decisions until it has the most complete information it can get about what the customer wants. The demand at the destination warehouses may have changed from the original estimates - one warehouse may want more of the product; another may want less. So instead of refrain from specifying quantities in advance, demand information can be monitored closely and sent, usually by satellite, to the truck driver, who can then make use of it to determine how much to unload at each destination. The truck is like a rolling warehouse. Similarly some shipping companies such as Orient Overseas Container Line have invested in information technology that allows their ships to postpone unloading decisions until arrival at destination ports. Their ships are thus floating warehouses. Such an e-fulfillment strategy is preferred if products are of high value and bulky and if customer demands are highly unpredictable.

The second core concept by Lee and Whang (2001) is to leverage existing resources to perform order fulfillment. One strategy they suggest that combines both concepts is resource exchange. "The product a customer needs may be stocked at many locations. If the stock at all the locations can be pooled to form a virtual resource, then wherever customer demand shows up, companies can utilize the nearest location." Another form of leveraging the infrastructure is to make use of the physical channels already in place for the delivery of other products. "Because those channels already exist, the incremental cost of transporting the e-tailer's product is often small. In order to consolidate the shipments of the e-tailer's products with existing product flows, good information on required shipment flows is crucial. The strategy is called leveraged shipments." For most e-tailers the order size from each customer is small and the cost of delivery is excessively high if customer orders are both small and distributed over a wide geographical region.

Therefore the cost of delivery is justified only if there is a high concentration of orders from customers located in close proximity - or if the value of the order is large enough. This innovation is ideal for products with stable demands that are less likely to distort the delivery-value density of the existing delivery network that are not too bulky to limit the usefulness of an existing delivery network.

“If the existing physical-flow channels go from supply sources only to retail outlets or other designated locations, delivering products from there to final customer destinations can be costly - and the last mile inefficient.” This strategy involves self-service as they address: “If, however, the locations or retail outlets are easy for customers to reach, then one solution is to have customers travel the last mile to pick up the product. That collaborative approach, in which suppliers ship the products to predetermined standard locations and customers do the rest, is the dicks-and-mortar (CAM) model of product fulfillment.” This works only if the products are easy to carry and customers can participate in the last mile with ease (Lee and Whang 2001).

Although theoretical, the Open Network -channel could facilitate all the above strategies by Lee and Whang in condition that is supported by the existing networks of Regular Line Operation -channel. Open Network assumes flexible allocation of shared resources for the pooled demand supported with advanced real-time information sharing. Only physical transfer demands involving very bulky goods, otherwise special handling requiring, or highly customer specific - moving projects - would be excluded. The grocery home delivery may be currently the most visible home delivery businesses (if the volumes in self-services are not recognized) but the illustrated development may show in the future something like the Everywhere Pick-up and Deliver –services to appear. These could be involved in most consumer pick-ups and deliveries but also in the first and last phases of physical transfer of goods in business-to-business operations. If the vision is about correct, the future global physical transfer portfolios are dominated by a combination of high volume unitized cargo shipments that consist of deliveries that are collected and distributed by market driven open networks.

One more strategy that Lee and Whang (2001) suggest is that companies should try to replace physical flows with information flows. Material flows are usually more expensive than information flows because of the costs of handling, loading and unloading,

warehousing, shipping, returns, spoilage and damage. If a physical good can be digitized (like a music CD can be converted to MP3 format), it can travel over the existing information and communications infrastructure. Information goods such as software and music are natural candidates for that strategy, which they call dematerialization. In this concept material product is substituted with digital one. A lot further going development of this concept would require technological innovations, “Startrek-technology”, that is able to dematerialize and rematerialize product, revolutionizing the transfer services by removing most physical transfer as such.

### **4.3 Container Transportation**

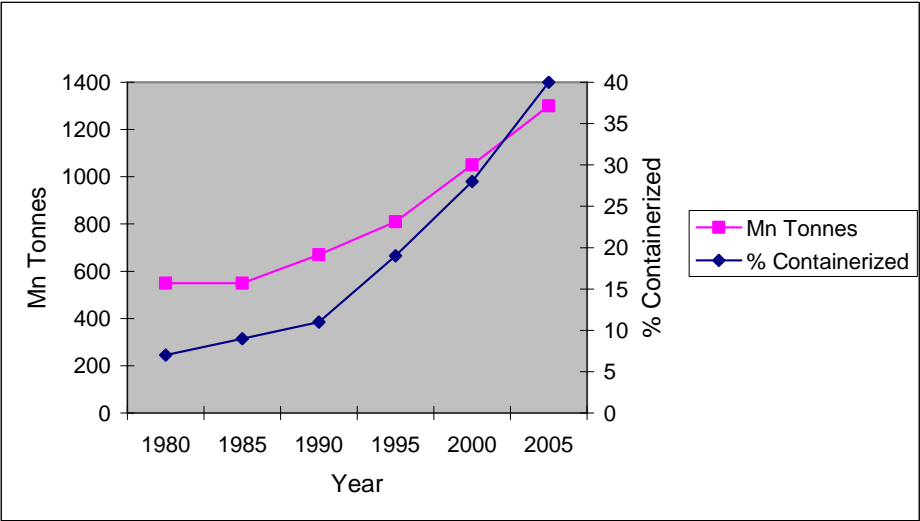
Container transportation earlier revolutionized some transfer services. It is however part of the continuum and dependent on the stage of technological and organizational development and related inventions.

#### **4.3.1 The Past Development to Current in Container Shipping**

The origin of container traffic is in the time after World War I when a number of railroads developed LCL (less-than-carload) container service. Some railroads used it as an online service, providing shippers with added security for their goods in these special shipping containers. Others used containers as intermodal units in conjunction with truck pickup and delivery (Muller 1989). It was surprising that the land-sea interchange point was one of the latest to receive benefits of containerization for intermodal movements of general cargo. Conservatism but also the high investments put in the existing structures may have hindered the development. Little by little the manual cargo handling of general ships became too expensive as the wages of stevedoring personnel raised (Woxenius 1993). The increasing amount of goods was no longer possible to transport using the existing ships and methods. The long time in port also made the ships uneconomical while building faster and bigger ships gave no relief to the total transportation time. The owners of goods were increasingly concerned of capital costs as the value of goods and interest rates rose. According to Woxenius (1993) this led to demand for fast transports of smaller shipments. The shipping industry reacted to these demands by loading the goods into large unit-loads, which were handled with special mechanized equipment.

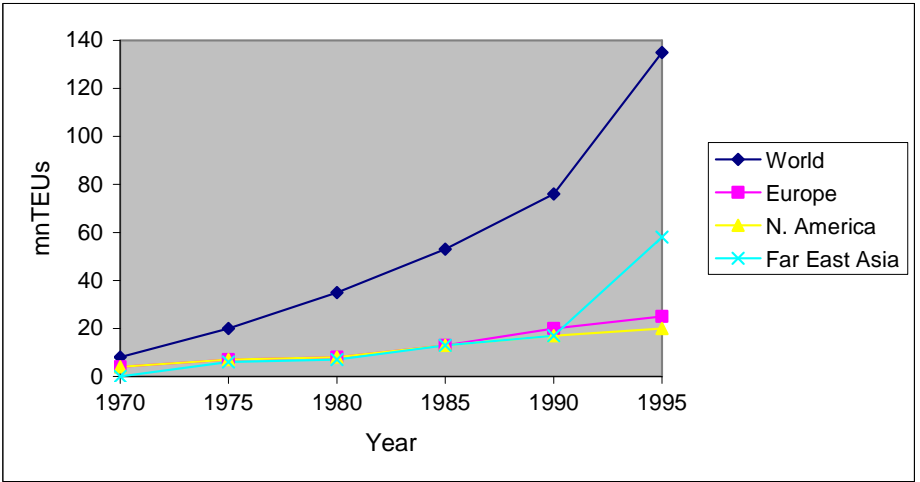
Containerization of ocean cargo however was not widely practiced until the 1956 “container revolution” (Muller 1989). The sea container transportation began in the North Atlantic by American ship-owners. Afterward it remained quite some time before intermodal containers were used on all ocean routes serving the United States and other countries. The first international container service started not before than in the 1960’s between Pori in Finland and Hull in UK. Later both the growth of general cargo and the percentage of general cargo that is containerized in global situation have been steadily growing.

Three different consultant or experts estimated the annual container shipping growth until year 2005 to be between 4.0% and 8.5% depending on the speaker (Dyna Liners 1996). In 2000 world container ports handling increased by 8.7% (Alderton and Rowlinson 2002) partly explained by increased transshipments. In the investigation made by Ocean Shipping Consultants (1995) European container port throughput was expected to grow from 30,3 million TEU (TEU = Twenty feet Equivalent Unit, standardized ISO-container) in 1994 to 43,0 million TEU in 2000 and to nearly 60,0 million TEU in 2005. The Chinese ports alone handled 48 million containers in 2003 and the Chinese officials have predicted that the throughput will rise to more than 100 million in 2010 (The Straits Times 2004). The shipping of containerized cargoes is growing quicker than general cargoes in general as illustrated in Figure 4-6.



**Figure 4-6** Growth of General Cargo (Alderton and Rowlinson 2002)

The growth in world container traffic is not uniform but has varied in the three main trading regions. Significant growth is seen in the Far East Asia lately (Figure 4-7).



**Figure 4-7** Growth in World Container Traffic (Alderton and Rowlinson 2002)

The growth of container shipping depends also on the type of it. Musso and Marchese (2002) state that in container shipping, Short-Sea Shipping (SSS) is reported to be one of the most dynamic markets of the shipping industry, both in feeder traffic and intra-regional trade. According to Drewry (1997) in 1996, world container SSS traffic of over 15 million TEU's in feeder traffic, and 16 million in TEU's in intra-regional trade, was reported. Further they then expected an average annual growth rate of 9.4% and 5.4% respectively to over 24 million TEU's and 21 million TEU's in 2001. According to Zachcial (1996) the growth rates per annum between 1994 and 2005 were estimated to be 5.5% in inter-Europe, 7.6% in feeder, and 6.3% in deep-sea, totaling 6.5% average annual growth for container shipping. According to Musso and Marchese (2002) the growing importance of SSS over the past decade is based on to a number of reasons: the growth of feeder traffic as a result of growing deep-sea transport and of reducing port calls of DSS (Deep-Sea Shipping). This connection also explains the fact that growth in SSS is mainly due to increasing containerized cargo: 44% growth over the years 1993-1997, against a 16% average growth of SSS (EU Commission 1999).

In the beginning containers were transported using conventional cargo ships, but soon special container ships were developed. These ships had cellular structures for stacking of containers on top of the other. Today fully cellular container ships represent more than 50% share of the container ships fleet in service and almost 100% of the slots on order. The rest is divided between different types of container carrying capacity. These ships may carry other cargo besides containers. An example of this is Con/Ro, a ship combination of a cellular container and a multipurpose Ro/Ro part (Containerisation International Yearbook 1996; Linde 1991). The most dramatic trend since the 1980's however has been the growing ship size. A rough division can be made into three size groups. 1. *Large ships* of 2500-4000 TEU in deep-sea shipping. However in the second half of 1990's several ships at the 6000 TEU range were built. The biggest ships currently are in the range of 8000 TEU's. The m.v. OOCL Rotterdam, the third SX-class post-Panamax container vessel with the capacity of 8063 TEU's and length of 323m that was christened on January 26, 2004 is being recognized as the largest containership in the world by the Guinness World Record in 2003 ([www.oocl.com](http://www.oocl.com) 2004), 2. *Medium size ships* 1000-2000 TEU and, 3. *Short-sea feeder ships* 500-1000 TEU and below. The number of large ships has been growing the fastest, but also the short-sea feeder ships

have been growing into the medium size group (Linde 1991). This is linked to the reduction of port calls of deep-sea traffic and growth of feeder traffic as thus better economies of scale can be achieved in both traffics facilitating bigger ships sizes. In Table 4-2 is shown the distribution of container ships according to their size.

**Table 4-2** World Containerships Fleet in Operational Categories in 2000  
(Alderton and Rowlinson 2002)

Sector	TEU Range	No of Vessels	% of Vessels	% of TEU Capacity
Feeder	100-499	376	15	2
Feedermax	500-999	482	19	7
Handy	1000-1999	801	32	25
Sub-Panamax	2000-2999	399	16	21
Panamax	3000-3999	230	9	17
Post Panamax	4000-4999	157	6	15
Post Panamax	5000-5999	60	2	7
Post Panamax	6000+	32	1	4

The speedier turnaround time for ship was one of the most important motivations to changed interest from conventional ships to container shipping. The time needed at the port was reduced when using containers instead of handling the general cargo with the more manual means at the port. Whereas a break-bulk ship might require many days to load and discharge its cargo by small crane and manpower, a container ship of similar size can enter, discharge, load, and clear a port in less than twelve hours. Since a ship is only earning revenue at sea, containers have become a dominant form of packaged goods shipping (Coyle et al. 1990). There is more time for transportation and thus with the intensified utilization of the capital of the ship containerization has allowed reduced freight level. Containerization has brought also labor savings to both the shipper and the liner shipping company. However containers cannot be moved without costly handling gears. Substantial capital expenditure in cargo handling has been accompanied by large investments in ports and as a consequence the share of equipment in total cost has risen. Therefore in maritime container transportation some of the flexibility of the transportation system has lost compared to traditional lo-lo traffic due to the more

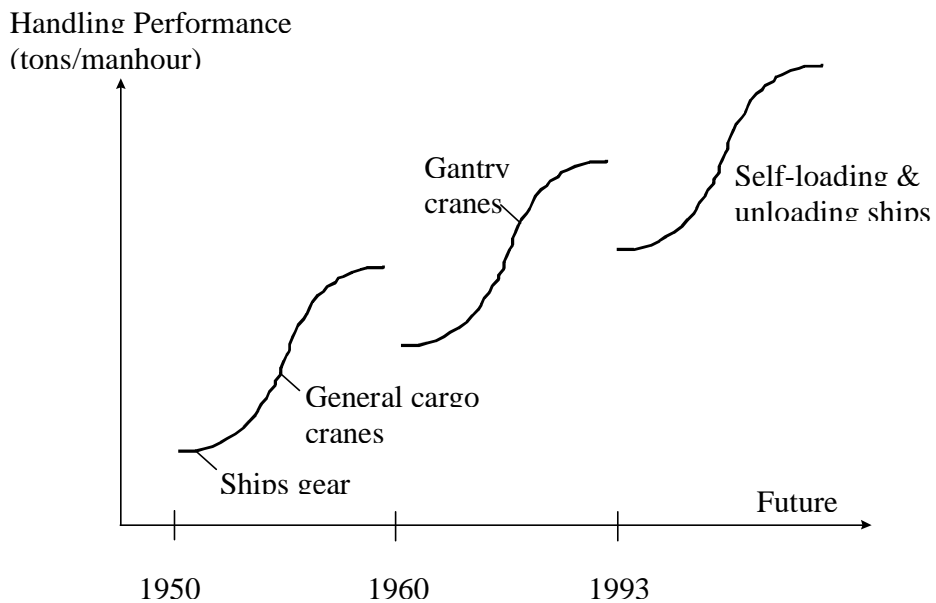


“industrialized” system. The procedures and physical structures are getting standardized and efficiency increased, but the structure is more rigid and less able to response to the changing demands of the long- and short-term fluctuations.

The efficient facilitation of the growth in container shipping brings with it also other challenges. Traditionally container shipping companies have promoted large capacity ships that provide low ocean freight charges but require more massive port facilities (Marine Log 1988; Magnier 1988). The attention given by the container shipping companies to the economies of scale in betting their business on investing in large ships may lead also to declining quality of customer service relative to the competition from land and air (Muller 1989). This line of inquiry has been prompted by the failures of some major container shipping companies, especially those employing ships of the “megaship” scale (capacity over 4000 TEU, Postpanamax). The plausible reasons are, among others, excessive transit delays due to congested ports and slow cranes, union strikes, and the inflexibility because of fixed routes, schedules and prices. The bigger ship the more difficult the land transportation side is to manage. Land transportation capacity of e.g. medium size ship of 2000 TEU’s is difficult to get in operation just before or immediately after ship arrival. For a minor advantage of the ship on sea, so it seems, the megaships have sacrificed the more important values of customer service, such as convenience, flexibility and door-to-door delivery (Vepsalainen et al. 1990).

Dependence of container shipping on shore cranes imposes two restrictions: first, the terminals with adequate cargo handling facilities may not be close to the source or destination of cargo and second, the large cranes may be inefficient compared to smaller cranes when working on smaller ships. Vessels in general - and the bigger ship the more likely - may be delayed in congested ports, by crane failures, strikes, high wind, or problems with the interconnecting trucks and trains. The congested logistics of the port area may, in fact, severely limit the use of megaships in the future. It is likely to be more difficult to find the longer time slot and longer quay length required for them compared to smaller ships. The basic technological conflict between handling and hauling considerations is that as the ship size is growing the handling capacity is expected to increase much slower (Jansson and Shneerson 1987). In high demand every hour spent at the port is expensive for the ship operator due to lost transportation time. Therefore

emphasis has been given in this dissertation to the cargo handling speed at port. One fundamental problem is to balance the supply of cargo handling services with the service demand in fluctuating conditions when ever bigger ships are challenging the port services. Unfortunately a common result is either low utilization of investments or lack of capacities in cargo handling facilities. Potential solution can be found in the development of cargo handling technology. Two periods of major change in general cargo handling performance can be distinguished (Figure 4-8).



**Figure 4-8** Development of General Cargo Handling Performance (Wijnolst et al. 1994)

The first period is related to development of modern general cargo ship. In spite of modern cranes on shore and on board, as well as wide hatches, rectangular holds etc., the handling performance in tons/man-hour had leveled off. The second period of change started with the introduction of container; many improvements in ship design, gantry cranes on board and on shore, efficient terminals etc., led to a phenomenal increase in productivity. However 30 years after this worldwide breakthrough, the productivity in the ship-to-terminal interface has leveled off again. In order to make short-sea shipping of unit-loads competitive, a third wave of change is required, based on very fast self-loading and unloading unit-load ship-terminal systems (Wijnolst et al. 1994). Some

authorities believe that by the end of this century major reductions in vessel port-stay times at high-volume ports will be achieved. This requires that 8 to 10 containers are lifted at the same time or high-capacity gantry cranes with seaside and shore-side trolleys capable of 100 container moves per hour are used (Muller 1989).

Another challenge related to the vessel construction is the open design of container ships to accommodate container moves: the hull needs to be reinforced and the deck construction requires heavy cellular guiding systems, strengthened hatch covers and decks, watertight ramps and doors, and other add-on structures. Therefore the largest ships, which necessarily rely on shore cranes, are feasible mainly in long, established routes with major ports and efficient terminal facilities (Vepsalainen et al. 1990). A solution of naval architecture of high speed ships have been proposed as means to achieve timely service for the customers and to improve shipping performance.

In the following several challenges are summarized by an industry player of a major company in port operations in deep-sea shipping. The views in maritime container shipping were shared in an interview in spring 2004 (Anonymous 2004). According to the interviewed three main players are involved in the maritime industry: Shipper, shipping line and terminal/port operator. Shippers are continuously after higher efficiency maritime transportation services. The services should be more reliable, accurate and cheaper - the benchmark for the shippers is air traffic believed to be 10-15 years ahead of maritime transportation services. One potential explanation is the better transparency in air traffic whereas shipping lines are not that eager to share information between parties involved. Shipping lines are facing these ever-higher requirements from their customers. The costs pressures materialize in the ever-bigger ships introduced especially in the overseas traffic in order to achieve economies of scale and thus reduced slot prices. However this works out only if the ships are full, therefore different kinds of networking initiatives are considered and implemented to feed the bigger ships. Alliances is an opportunity for the shipping lines to react to the growing needs – obviously it could allow to better utilize the ship capacity but may also turn to offer better service level (frequency, geographical coverage etc.) for the shippers. The opportunities of shipping lines to further grow in size in deep-sea shipping with acquisitions, in order to consolidate the cargo flows, are somewhat limited.

The trend of globalization has affected mainly containerized operations. According to World Bank (2001B) during the 1990's a number of operators and major shipping lines emerged to invest in and take control of a large number of terminals all over the world. Port terminals are geographically fixed for by nature the investments required in the industry are significant and difficult to reallocate. Therefore single terminal operators are rather weak in bargaining power. However establishing a network that consists of terminals in diverse locations may improve the position, for the shipping line may turn to be more dependent on the service offering. Some global terminal operators like A.P. Møller - Mærsk Group (APM Terminals), Hutchison Port Holdings (HPH), PSA (Port of Singapore Authority) and P&O are in such a situation. The five or six biggest global operators together have already 25% share of the global port terminal operation business, however not all them are vertically integrated in the supply chain. In order to be involved in the market of major ports in the eyes of the shipping lines, the facilities required and service level expected is a given factor. The competition between the port terminal operators is based on price and connectivity to the line network. In case of hub ports connections to gate ports (ports with hinterlands) are important. The geographical position as such however is not so important factor anymore. As a consequence of the costs pressures in the operational port work we are likely to see increase of automation in general or in particular operations at least semi-automatic solutions in the near future. This development however may take place in different sequences in different countries depending on the pricing of labor and manual work (Anonymous 2004).

Other than the facilities and performance requirements set for the major ports there are no real harmonization pressures currently in the port operation business. The shipping lines understand that the similar performance cannot be expected in all ports. Therefore class I ports like Hong Kong, Singapore and Rotterdam and class II ports are not equally evaluated. Also if the shipping lines in overseas operation estimate that the performance of a port is not satisfactory they may call only the major port of the area and leave other shipping lines to take care of the feeder traffic (Anonymous 2004).

The maritime transportation has always been global business. However concerning the further globalization of port terminal industry there are forces that may limit such development - like EU acts in the European Union area. On the other hand some major

companies in the port terminal operation tend to grow their overall business by vertically integrating - Hutchison Port Holdings for example is involved in logistics as well as A.P. Møller - Mærsk Group with its APM Terminals has wide presence in many areas of the container shipping business. Some others like PSA seem to remain in the port terminal business (Anonymous 2004).

Although the origin of container transportation is in maritime shipping today the business processes are increasingly extended over the boundaries of a single transportation mode. The current container transportation chains typically consist of various transfer phases from manufacturer to retailer store. They easily cover truck and rail in addition to maritime mode (possibly with separate feeder and deep-sea shipping phases). The connections between transportation modes in container shipping are vital to facilitate efficient operation over the transfer chain. Therefore the development challenges of entire container transfer chains and networks involving land traffic are investigated separately in more detail in the dissertation. The capacity challenges and service issues concerning maritime shipping, port operations, secondary cargo handling and their mutual interaction are also extensively discussed in chapters 5 and 6.

#### **4.3.2 The Features of Containerization**

The introduction of containerized cargo is seen the most important technological change to achieve efficiency in cargo handling. As a consequence containerization has offered a higher level of customer service by reducing the time needed for delivery but also reducing the risk for stealing or damaging the cargo. Containers are routinely used for items of high value such as industrial components or consumer durable (Kim and Sachish 1986; Talley 1986). However even bulk cargo, such as low paying forest products, can be shipped in containers that protect it through the moves from the mill to the customer thus reducing the expenses of packaging (Abrahamsson 1982). The cargo volume and type, transfer services, existing routes and land connections as well as port facilities etc. define whether container transport is chosen or not. The standardized (ISO-) container is not always suitable to certain product dimensions, or the container capacity and transportation batch size are too different from each other. There is no exact criteria - e.g. \$/ton or density - for the cargo to be transported in containers but finally the

physical dimensions (length, width, height and weight) define the cargo's suitability for container transportation. Container itself is not necessarily compatible with the transportation vehicle. The availability of return cargo may also be a selection criterion for a ship calling a port to balance import and export.

The standard container unit is needed for "intermodalism" with flexible connections to short sea operations, trucking and railroads (Magnier 1988). Benefits of container shipping are listed as follows (Branch 1982; Fair and Williams 1975; Muller 1989):

- Greatly expedited service
- Reduced transit times
- Reduced costs because due to higher utilization of vessels and reduced labor costs ashore and aboard ship
- Greatly reduced damage
- Protection from pilferage
- Reduced packing costs
- Reduced Ocean freight rates
- Reduced insurance premiums
- Eased identification and tracing of shipments
- Less paperwork because of the smaller number of items listed

These advantages have not yet realized in full potential measure. The service level is influenced e.g. by the size of a ship. In liner shipping thin cargo flow may cause low utilization level of the carrying capacity and respectively in contract shipping maximizing utilization of the ship capacity may result in long delay times. In many ports a lot of labor is still needed due to the local regulations, however solutions like self-discharging ships (if allowed by the regulatory parties) may reduce the labor costs. Packing costs are reduced for container protects cargo from weather and damages during cargo handling and transportation. This is subject to adequate fastening of cargo in the container especially in rough seas where the accelerations may cause damages. Damages are possible also e.g. if the condense water protection is neglected. Reduction in ocean rates is dependent on the efficiency achieved and the competitive situation on the markets. The development of information systems and electronic data connections again have further eased the tracing of shipments and reduced paperwork.

Containerization set certain prerequisites and also has some undeniable disadvantages. These early statements (Branch 1982; Fair and Williams 1975) are still partly relevant despite of the last decade's progress especially in terms of harmonized procedures:

- High capital cost of containerization
- Lack of standardization of equipment and methods of transfer
- Lack of port facilities, causing congestion and delay
- Delay from customs and other government inspection procedures
- Local restrictions may prevent transportation by road of loads exceeding certain dimensions or weight
- Lack of arrangements for through billing and coordinate liability
- Lack of adequate control of the return of containers
- Tare weight of the container

The organizational innovations and the developed information systems have reduced the coordination problems. The port facilities in developed areas are in higher level than in previous years, but in some areas lack of port facilities (and also other infra- and superstructures) prevents efficient utilization of container shipping. Effort has been given in harmonizing dimension and weight restrictions e.g. in land transportation. The use of standardized equipment in general has been progressed (see Table 4-3).

**Table 4-3** Standardized ISO-Container Sizes (Wijnolst et al. 1993)

ISO Designation	Length		Width		Height		Rating
	Ft	M	Ft	M	Ft	M	
1A	40´	12,19	8´	2,44	8´	2,44	30
1AA	40´	12,19	8´	2,44	8´6´´	2,60	30
1B	30´	9,13	8´	2,44	8´	2,44	25
1BB	30´	9,13	8´	2,44	8´6´´	2,60	25
1C	20´	6,06	8´	2,44	8´	2,44	24
1CC	20´	6,06	8´	2,44	8´6´´	2,60	24
1D	10´	3,00	8´	2,44	8´	2,44	10

\*) MGW stands for maximum gross weight

On the other hand the standardization development has also gone to an opposite direction at the same time. It is common that as the principal design matures, more

special solutions appear. In containers this can be seen e.g. in the development of different dimensions and of special types. The reason behind is the aspiration on the other hand to meet the specific cargo requirements but on the other hand to attract new cargoes and thus increase transport volumes. The intention is to fully utilize the transfer capacity for economies of scale. In addition to the standardized containers several other sizes are used - e.g. 45-foot units are relatively common in Europe whereas in the U.S. traffic 48- and 56-foot unit are used. There is difference in container heights for example 9'6'' high containers are commonly used by some operators, but additionally other not standardized heights like 9' can be met. The size of pallets (for Euro pallet 800\*1200 mm) has been taken into account in designing of some new units. The capacity of the original 20-foot ISO-containers is 11 pieces of euro pallets. Only slightly wider, later designed 'pallet wide' units may accommodate 14 pieces of euro pallets. Some cargo types have specific container design requirements. As a result reefer containers equipped with refrigeration units are used for temperature controlled cargoes, tank containers are used for gas, liquidated gases and liquids, bulk containers for example for granulates, etc. Cargo handling requirements are taken in account when instead of normal dry container e.g. open side container, open top container or flat is selected. Open tops are also used to accommodate extremely high cargoes.

Container service has brought about new and different operating and management concerns for the shipping company. A large investment in containers is required because, while some are at sea, many others are being delivered inland or are being loaded there for movement to port. Although a ship might carry a thousand containers, an investment of 1,500 to 2,500 containers is necessary to support that ship (Coyle et al. 1990). This involves management of the fleet of different types of container units – the more variability, the more complicated coordination challenge. This however also tends to increase compatibility challenges. The more different types and dimensions are in use, the more flexibility is required from the transport vehicles and cargo handling equipment. For example the location of lifting points may vary according to the container size. Additionally the different types of containers may need special procedures in handling. Also based on certain instructions or limitations for different types and sizes the location of containers is defined on-board ships. Reefer containers need to be plugged in when in ships and in purpose built storage areas. Containers with hazardous cargoes have to be



located according to certain rules in ship cargo holds and in some ports in special areas with drainage wells.

#### **4.4 Prospects for Future Development in Container Shipping**

The relative success of container shipping compared to many other forms of transportation would indicate that it has served the customer needs well. It also seems that the parties work together simultaneously supporting their individual profit making targets. Currently it is namely typical that - depending on the number of transportation phases and the level of vertical integration - several legal entities (companies) representing different transport modes are involved in container transfer chains. In order to establish more functioning entities the co-operation between modes should be further improved. It looks like however that in addition to between supply chains; the competition between transportation modes is getting more intensive. Therefore it is not for sure that the current structures and concepts in container shipping are going to remain as they are either.

According to Meersman and Van der Voorde (2001) declining real transport costs, increasing value of goods transported a declining weight to volume ratio, along with diminishing telecommunications and computing costs encourage a concentration of specialized production. On the other hand companies producing products requiring customization have moved the customization location as close as possible to the end-market. Brooks (2002) state that this means that in an era of supply chain management, these multiple moves are dependent on continuous improvement activities, regular and frequent performance monitoring and re-evaluation of the network of manufacturing and distribution partners. She continues that with a global perspective, the conclusion for container shipping is one where large volume routes will continue to dominate but, at the level of the trader, the product mix and route will be less predictable. In the nearest future container trade is growing very rapidly. According to Page (2004) for example the world container trade volume grew by 10% in 2003 and more of the same was expected in 2004. However Brooks (2002) states that although there will be some growth attributed to rising population, and significant growth due to the expanding middle class in many of the world's most populated countries, growth in container transport demand

arising from the penetration of containerization is less probable, as containerization will soon reach maximum penetration except on low volume routes.

Wijnolst et al. (1993) present a set of innovation triggers in shipping that are applicable to container shipping – and difficult to see a reason why not more generally in container transfer services. The five classes of triggers of innovation they define are:

1. Physical law triggers
2. Geographical conditions triggers
3. Economic parameters triggers
4. International regulations triggers
5. (Technological) change in related sector triggers

The physical law triggers are driving the development in the cargo handling and physical transportation equipment of the goods and the results will probably appear in the form of technological innovations for example in speedier operation. Geographical condition triggers influence the physical dimensions of the transportation equipment but also the volumes to be transported (e.g. route length). This is closely linked to the economic parameter triggers that are involved in business considerations of different parties of issues like fixed/variable cost share and economies of scale achieved as well as competition between modes. Regulation is normally considered to in many case prevent innovations. International regulations triggers are involved when laws and regulations drive actions and a source of change. Prevention of pollution for example may limit land transport and may thus lead to new (organizational and/or technological) innovations in short-sea shipping. The triggers in related sectors are potential sources of innovations in IT for transfer coordination and new organization models or for example increased energy efficiency.

If revolutionary innovations are going to take place in transfer services that could among other consequences e.g. lead to diminish of container shipping. It is yet more probable that the future development in container transfer chains will take the form of inventions and a continuum of gradual innovations possibly facilitating several alternative development paths in changing environments. Either way, some likely developments and potential structures are illustrated in this paragraph as indications of the more general

developments in the societies. There are some areas in container transfer service industry that are possibly going to be more relevant than some other areas in terms of innovation. Among the technological issues, the technological solutions required in different areas - especially in information technology - to enable (the predicted) networking between organizations are going to be important. The related standardization and modularization are relevant issues also from the physical transfer services point of view. The relations of organizations, the related ownerships structures of the future, coordination issues, and how container chains are going to be linked to the other forms of transportation as such however may prove to be very important issues. However although change would be beneficial from the innovator point of view (in the container transfer chains), there are inhibitors that decelerate the change. The incoherent targeting within the companies in the industry, the investments made in the existing structures, aggressive protection of market shares by the competitors etc. to mention some of them. Therefore maybe the most important point in the organizational aspects in the development of container transfer services is the central role they play on how the innovations are implemented, and how the diffusion of innovation in a wider scale will be organized.

#### **4.4.1 Development Trends and Needs in Container Transfer**

According to an investigation by the Ministry of Transport & Communications of Finland (1998), container transportation gains a central role in the future intermodal transport. The use of container units is predicted to grow and the technological developments are connected to container transport. Technology is stressed in the development, mainly involving cargo handling, tracking and tracing, and coordination. Increasing intelligence in transport units, semi-automated (instead of automatic) systems in physical transfer, telematics solutions and other IT-intensive systems were expected to appear in the arena. Since the time of the investigation a limited progress has been seen in intermodal transport (unlike e.g. in telecommunication industry). This may be related to conservatism of transport equipment manufacturing, transport service and shipping industry. On the other hand organizational structures may prevent implementation of new solutions in multiple organizations simultaneously. Therefore more development potential would be expected to be found in organizational issues. The central issues of the investigation are concluded in Table 4-4.

**Table 4-4** Development trends of intermodal transport  
(Ministry of Transport & Communications, Finland, 1998)

Inermodal transport units	Transport, handling and terminal operations	Tracking & tracing, transport chain coordination
<ul style="list-style-type: none"> <li>• No plans currently exist for a specifically intermodal transport unit.</li> <li>• The width of ocean line containers will be unchanged, whereas the lengths will be varied.</li> <li>• Container use will increase.</li> <li>• The sizes of containers and pallets will become commensurable.</li> <li>• The use of transport units outside the transport chain will increase.</li> <li>• Trailers will keep their position in regional transport.</li> <li>• Transport units will become intelligent (information on cargo, unit and transport methods).</li> <li>• New materials may replace old ones as prices are lowered.</li> <li>• In closed systems the need for special solutions will continue to exist.</li> </ul>	<ul style="list-style-type: none"> <li>• Evolution will lead to increasing concentration of operations (points where transport modes meet and value added services are performed).</li> <li>• Intermodal transport growth will lead to development needs in big but also smaller freight centers.</li> <li>• Container movement will take place on fast trunk lines, and handling will be concentrated to efficient terminals.</li> <li>• Terminals must be able to adapt their operations to changing transport requirements.</li> <li>• Growth of container use will allow increasing automation.</li> <li>• Large container vessels will dominate ocean transport and turnaround times in ports will be very short.</li> <li>• Cargo handling technology will be mounted on the vessel if required.</li> <li>• Simultaneous handling of containers will increase operational efficiency.</li> <li>• The need for semi-automated systems will be bigger than for complete automation.</li> <li>• Container warehousing will be further developed.</li> </ul>	<ul style="list-style-type: none"> <li>• Telematics will be a central factor for securing the competitiveness of intermodal transport.</li> <li>• Advanced planning &amp; control systems will be needed for integrating the transport chain.</li> <li>• The users require advanced tracking and control systems.</li> <li>• Identification and positioning of transport units will be developed, as well as cargo detection, climatic control and information transfer capabilities.</li> <li>• The development of general solutions is hampered by the lack of global standardisation.</li> <li>• Telematics systems must be adapted to various demands, and interoperability will be a necessary prerequisite.</li> <li>• There are over 10 million containers owned and operated by a number of different actors in the world; this will require the systems to be operated simultaneously even when different standards are used.</li> </ul>

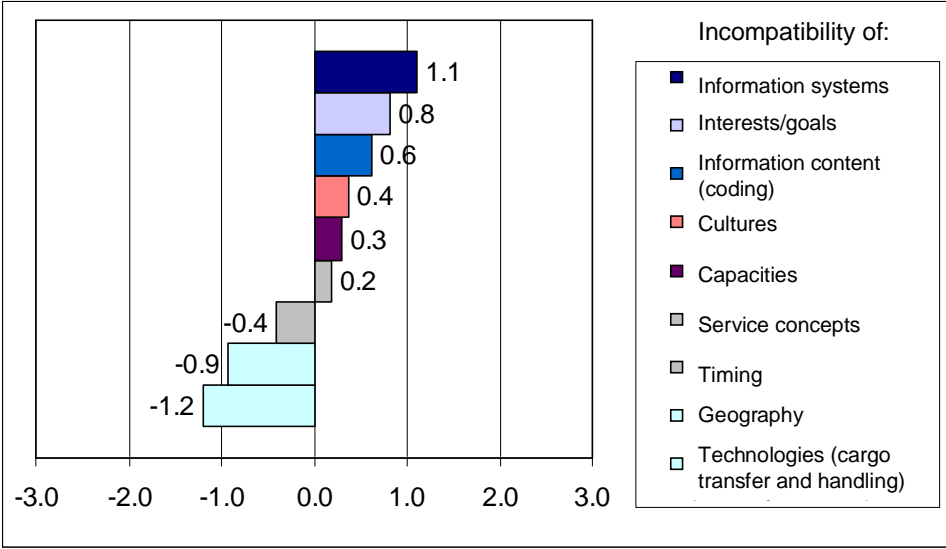
In an investigation by Bask and Laine (2000) several business and operations related issues were expressed besides technological development. In the investigation specialist in container shipping industry in Finland were interviewed. The main future development needs according to the interviewed are listed in Table 4-5.

**Table 4-5** Main Future Development Needs in Container Transport Chains\*

Services	No	Example
Efficiency (8)	1 1 1 1 1 1 1	<ul style="list-style-type: none"> <li>• Increase in overall efficiency</li> <li>• Shortening of total transport chain cycle times</li> <li>• Constant flow of containers</li> <li>• Shortening of ships port times</li> <li>• Faster crane lifting operations</li> <li>• Development of rail transport speed, frequency reliability and service concepts</li> <li>• Decrease in number of ports in general, fewer liner shipping ports</li> <li>• Faster terminal operations</li> </ul>
Reliability (2)	1 1	<ul style="list-style-type: none"> <li>• Development of reliability in domestic transports</li> <li>• Decrease of failures in port operators activities</li> </ul>
Capacity (2)	1 1	<ul style="list-style-type: none"> <li>• Better availability of special containers</li> <li>• Better availability of land transportation</li> </ul>
Flexibility (2)	1 1	<ul style="list-style-type: none"> <li>• Increase of flexibility in general</li> <li>• Development in customs operations</li> </ul>
Pricing	1	<ul style="list-style-type: none"> <li>• Right pricing in land transportation operations</li> </ul>
<b>Coordination</b>		
Information management (10)	4 1 1 1 1 1 1	<ul style="list-style-type: none"> <li>• Development of information sharing and utilization among chain members</li> <li>• Availability of pre-information</li> <li>• Development of information management in general</li> <li>• Faster feedback of capacity requests from shipping companies</li> <li>• Easier finding of adequate equipment for land transport</li> <li>• Better time matching between transport vehicles and containers</li> <li>• Development of information sharing between port operators and other parties</li> </ul>
Cooperation (7)	2 2 1 1 1	<ul style="list-style-type: none"> <li>• Development in cooperation among chain members</li> <li>• More efficient combining of return loads</li> <li>• Easier finding of different service operators in the container transport market</li> <li>• Development in matching of opening hours in the chain (8 h vs. 24 h)</li> <li>• Better total optimization of routes</li> </ul>
Standardization (6)	1 1 1 1 1 1	<ul style="list-style-type: none"> <li>• Development of generic standard for information sharing</li> <li>• Development of currently unclear EU standards</li> <li>• Standardization of information shared among chain members</li> <li>• Development in container standards, decrease in number of types of containers</li> <li>• Development of packages to be more optimal to container sizes</li> <li>• Simplification of routines in the chain</li> </ul>
<b>Technologies</b>		
Information systems (4)	1 1 1 1	<ul style="list-style-type: none"> <li>• Development in communication systems, decrease in use of telephone</li> <li>• Automation of information sharing in the chain</li> <li>• Development of IS systems for total route optimization of the chain</li> <li>• Development of electronic information exchange among chain Members</li> </ul>
Track and trace (4)	2 1 1	<ul style="list-style-type: none"> <li>• Better availability of real time info among members in the chain</li> <li>• Enabling of tracking and tracing from computers</li> <li>• Better utilization of tracking and tracing in the chain</li> </ul>
Transport technology (3)	1 1 1	<ul style="list-style-type: none"> <li>• Development of stuffing and stripping capabilities</li> <li>• Development of lifting capabilities of containers to road vehicles</li> <li>• Development of port operations</li> </ul>

\*) Figures refer to number of responses by experts in interviews

In the interviews the concentration of services and fast trunk lines as a source of efficiency was mentioned in terms of fewer liner shipping ports and a general decrease in number of ports to call. Actions to increase efficiency and coordination issues with information management, cooperation and standardization were given the most emphasis. Technology was mostly seen in a supportive role instead of being active driver in the development. Similarly the organizational issues (coordination etc.) were apparently more seen as aids to achieve the targets, not an object of development itself. The smooth overcoming in inter-organizational interfaces ensures functioning container chains. Therefore the compatibility challenges were enlightened with few questions in the interviews. Individual interviewees saw remarkable compatibility challenges, the majority however did not see strong implication of compatibility problems (Figure 4-9).



**Figure 4-9** The Incompatibilities in the Interfaces between Organizations in Container Transport Chains (Bask and Laine 2000)

The result may be an indication of the fact that container transport is relatively mature concept and several forms of action have been potentially tested already decades ago. As one, the compatibility issues in technologies of physical transfer of goods didn't appear to be a problem according to the interviewed. Another is that the geography didn't seem to be a challenge. An explanation may be that the selection of partners has been done

already among those who offer services in a particular geographical area. Therefore other service providers are automatically excluded from the considerations.

Differences in interests and goals seem to remain a challenge in inter-organizational relationships. The interviewed expressed reasoning: lack of optimization of the entity, overlapping roles and competition between, and potential extra costs while another party is benefiting of the increased efficiency. The information systems and information content were among the problematic issues between the organizations - this is an arena where practices are not established and the changes also in the surrounding society are the fastest. The lack of standards and will to construct own (closed) information systems were mentioned by several interviewed (Bask and Laine 2000). The entire picture painted was not of a nature to support diffusion of innovation within the industry.

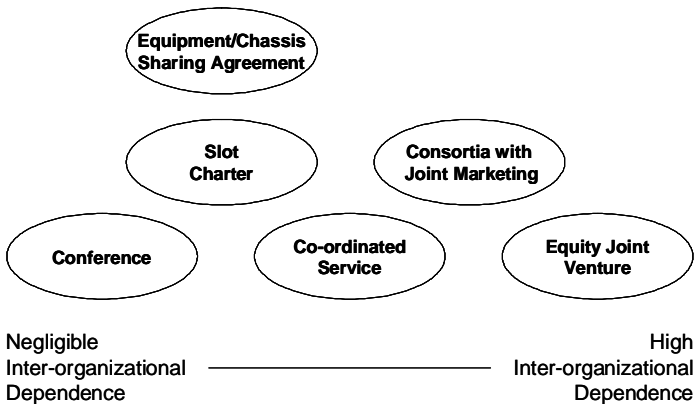
The point of view above is operative and refers to already existing system. The views investigated by the Ministry of Transport & Communications of Finland (1998) are maybe more far reaching. Therefore due to different approach the challenges detected and future paths illustrated tend to differ accordingly. Depending on the stage of constructing a chain, different challenges appear. The geographical compatibility for example is less relevant issue - most incompatibility problems have been solved already when the chain is able to pass cargo. The challenges also differ in different parts of the container transfer chain. For example the challenges in compatibility of capacities in ports are common but less addressed in the distribution phases.

In terms of compatibility in the near future the biggest development needs in container transfer chains are where the incompatibilities are the biggest. The future development may however be asymmetric in different areas of business thus twisting the previously achieved balance in between and creating new challenges. Also unexpected incidents may take place in the environment. This time it is the global political instability and the threat of terrorism – therefore security practices has risen as an issue lately.

#### **4.4.2 Organization in Container Shipping**

Strategic alliances have been common in shipping industry already more than a century. According to Brooks et al. (1993) lately a dramatic shift in the strategies of the ocean

carrier firms has been witnessed. The companies have engaged in mergers, acquisitions, and strategic alliances, seeking to develop integrated door-to-door capabilities in response to rapidly changing environments and increasingly demanding customers. Brooks et al. (1993) however write that as shipping has already been global industry for centuries, the strategic alliances driven by market access requirements are not such a major issue as for some other industries. More relevant in the research is to focus on the strategic use of alliances to share benefits such as economies of scale, co-opting competition or raising barriers to entry. All strategic alliances comprise cooperative arrangements between companies, but they may be used for different purposes. Conferences may be the least cooperative of strategic alliances, since in their simplest form they may be nothing more than price-fixing agreements to eliminate price competition between members. On the other end vessel-sharing consortia with joint marketing agreements and management committees, like equity joint ventures require deep cooperation as firms become partners in the new venture (Figure 4-10).



**Figure 4-10** Range of Strategic Alliances in the Container Transport Industry (Brooks et al. 1993)

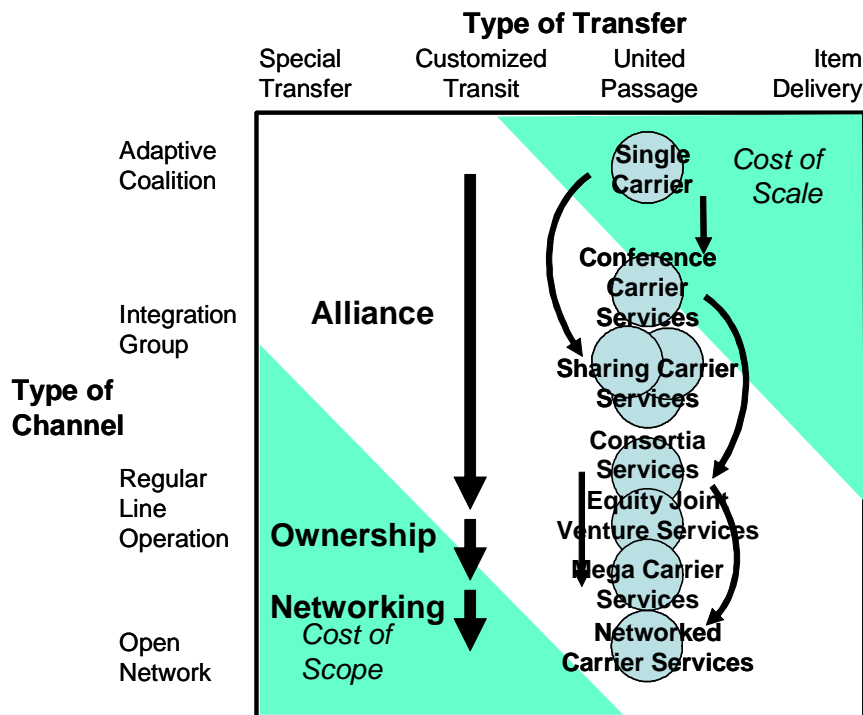
Conferences, the original interfirm agreement of the shipping industry, grew out of the excess cargo capacity prevalent in the Europe-Far East trades in the latter half of the 19<sup>th</sup> century. Through coordinated sailings, pre-determined prices, and cargo volume ceilings, the industry controlled predatory pricing and competition. It has been often argued that non-conference carriers provide an effective check on the power of the conferences - the



future of the conference as an interfirm partnership is in doubt. Slot charters, coordinated services and equipment-/chassis-shearing agreements are used when the customer service requirements and thus required investments in ships, containers, terminals, etc. exceed single companies' financial capabilities (estimate: fixed costs rose between early 1980s to early 1990s from the largely vessel-related 30% to 70% due to the investments in EDI, containers, and chassis). In slot charter carrier on a route may offer to another carrier fixed number of spaces, or slots, per sailing for a fixed period of time at an agreed price (although rival companies). Slot charter agreements are common in co-ordinated services where the financial arrangement for the space is often separated from the contribution of the ship servicing the route. The companies coordinate sailing schedules so as to jointly offer a regular fixed-date sailing schedule. In order to receive savings but simultaneously reduce the risks to the core business, companies may also form alliances in the non-core part of the business like in investments in containers or other equipment in supporting areas. Similar to slot-sharing agreements are also the equipment-sharing agreements to share the costs and utilization of port-side cranes in company-owned terminals (Brooks et al. 1993).

Since 1970s consortia has been common in liner shipping industry. That time many Western operators began to rethink their strategies to respond to the mounting capital cost of ships and the aggressive marketing of Oriental shipping companies. In many cases this resulted into vessel-pooling consortia-instances where shipping companies contributed ships and other resources to a new jointly owned entity. More frequent service could be offered than by any of the companies alone. However consortia are declining as individual firms lose their identity to the consortium. It has also proven to be slow to respond to the changing needs of the marketplace (Brooks et al. 1993).

“The ocean transport industry employs a variety of types of strategic alliances to grow cooperatively or, as is often the case, to limit competition” (Brooks et al. 1993). Due to the latter aspect the efficiency may end up far from optimal from the customer point of view although beneficial for the service providers. The organizational issues are here reviewed presuming efficient models of the Transfer Service Matrix - in the first place related to the vertical axis of the TSM, type of channel. For the illustration of the development the container services offered are positioned in the TSM (Figure 4-11).



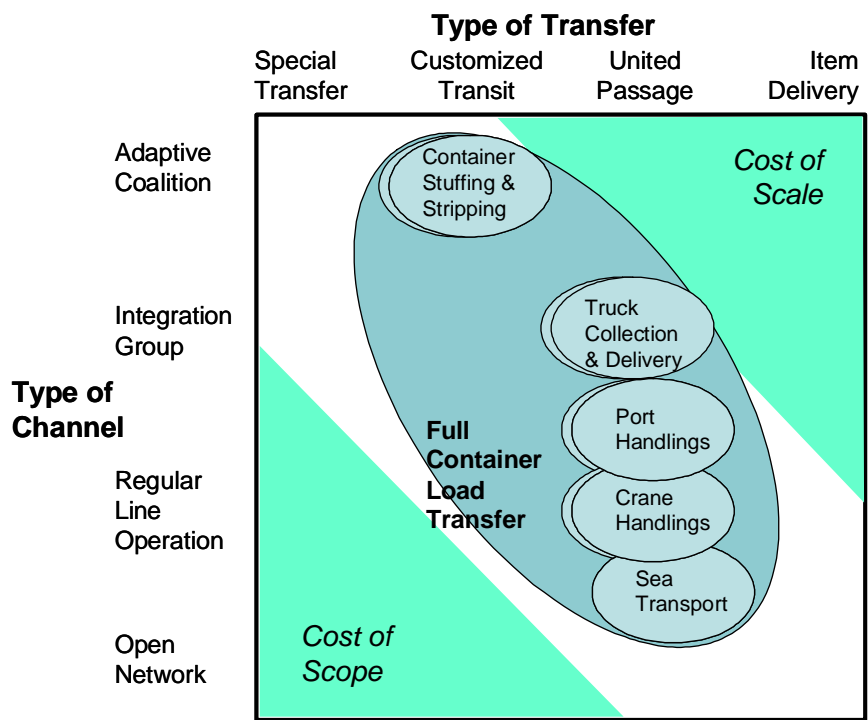
**Figure 4-11** Influence of Strategic Alliances and Ownership in Container Shipping Services

The different alliances are positioned based on the inter-organizational dependence. The thick arrows express the organizational trends in (maritime) container industry whereas the thinner arrows indicate typical development steps in the formulation of new organizations. The positioning of conference services in the Transfer Service Matrix seems to reflect the same phenomenon of inefficiency that has been experienced in real life. Sharing Carrier Services in the figure include coordinated services, and slot charter and equipment-/chassis-sharing agreements based services. Consortia services (as all the container transport services by definition) are located to the column of 'United passage' in the demand side. How can be explained that although consortia services are positioned in the efficient diagonal of the Transfer Service Matrix, a consortium is a diminishing organization type in the industry? Part of the answer is that the demand they are experiencing is probably not anymore compatible with the features of 'United passage', but as Brooks et al. (1993) argue: "...consortia have proven to be slow to respond to the rapidly changing needs of the marketplace." In addition there may be reasoning that is

not related to efficiency, but to other commercial characters like loosing of identity of consortia member companies. In equity joint ventures the cooperation is even deeper. This mode of alliance - if continues to grow with multiple services and expanding geographical coverage - may show a path to in the literature defined mega carriers of the future. Networking again could offer a logical development stage. In diminishing consortia it reduces the risk that the identity of a company is lost in a network and increases the flexibility to respond to changes in the markets.

### 4.4.3 Container Shipping Service Portfolio

Although the Transfer Service Matrix is denoted to high level analysis of transfer services it can be used also for relatively detailed level positioning and visualization of service portfolios. An example for a door-to-door container transfer portfolio in short-sea shipping is presented for a standard (ISO-) container is presented in Figure 4-12.



**Figure 4-12** Splitting of Door-to-Door Container Transfer Portfolio

This portfolio includes the typical service stages where truck transport is used in the pick-up and delivery. Using rail instead of truck transport is possible only in limited locations with rail connections. If rail transport is used for longer land transportation legs, in many practical cases truck transport is required in both ends of the portfolio for the more customer dedicated service phases. Therefore rail transport would be presented as an additional phase(s) in the portfolio.

Container stuffing (loading) phase in the beginning of the service portfolio and stripping (unloading) phase in the end of the portfolio are relatively customer specific services. Therefore typically shippers/consignees (customers) using door-to-door service have their own organization with the resources and skills required - loading and unloading of container may be an elementary part of their processes - otherwise an external service provider with the same set-up would be required in their premises for each container unit. It is possible that the customer lacks the resources required, and no highly specific handling for their products is required, and they possibly even lack the skills for stuffing. In that case they may postpone containerization to services provider's terminal and use during the first transfer stages other methods of transfer instead. Similarly on the other end the container may be stripped in the terminal (terminal-to-terminal container transfer).

The following stage of truck transfer is typically outsourced from a service provider. The solution is possibly arranged by a forwarding company or service integrator, or it may be ordered directly from the hauler company who is actually proceeding the physical transfer. The unit to be transferred itself is standardized however because of the point of origin and the point of destination are specific, the routing and scheduling require certain level of customer specific arrangements.

Unless the cargo inside the container unit requires special care, port handling of a normal container requires only positioning on the container yard according to the destination, estimated time of further transportation and possibly weight. Similarly the only influencing factor in crane handling is the position in the cargo hold based on container size, port of origin/destination, loading and unloading sequence and possibly the weight (for ship stability and stress). These phases consist of simplified transactions targeting to minimum exceptions and variations in the processes.

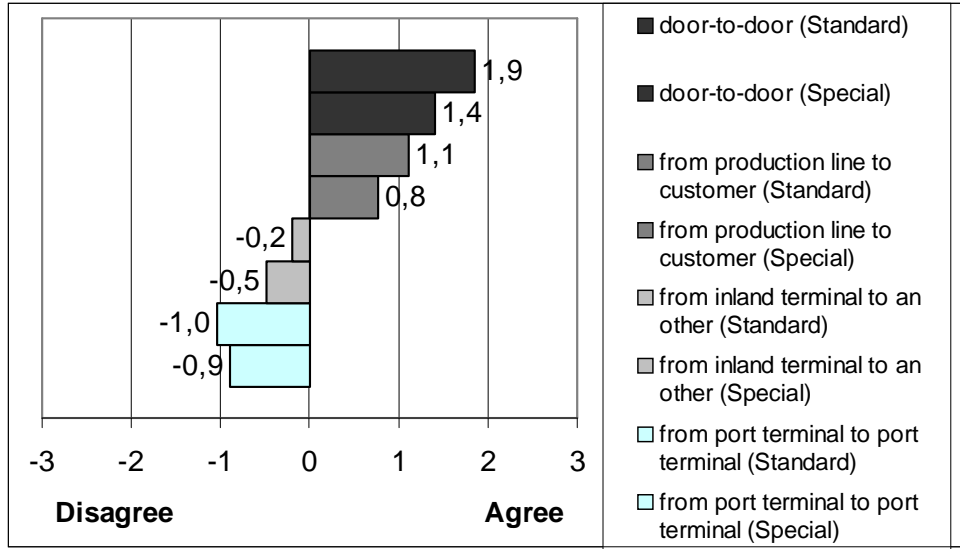
The sea transportation leg in container transfer is normally a very uniform process. Most of the container ships follow certain schedules and routes between fixed ports. In terms of physical transfer there are in principle no restrictions to place a standard container to a ship dedicated for containers if only a slot is available. When a normal dry container is transported no additional tasks are required during the transfer either, like possible checking of the temperature in case of a reefer container.

#### **4.4.4 The Scopes of Service Portfolios in the Future Container Transfer**

In an investigation by Bask and Laine (2000) interviews were carried out among container transport industry specialists in Finland to find out their views about the current state and future development opportunity in container transport. In the investigation 27 persons (representing different organizational levels) were interviewed from 14 companies or organizations involved in container transfer chain in Finland. An extensive pattern of questions were asked. The measures used had seven steps and ranged between completely disagree (-3) to completely agree (+3). The results for each alternative are presented as an average of the responses of the interviewed persons.

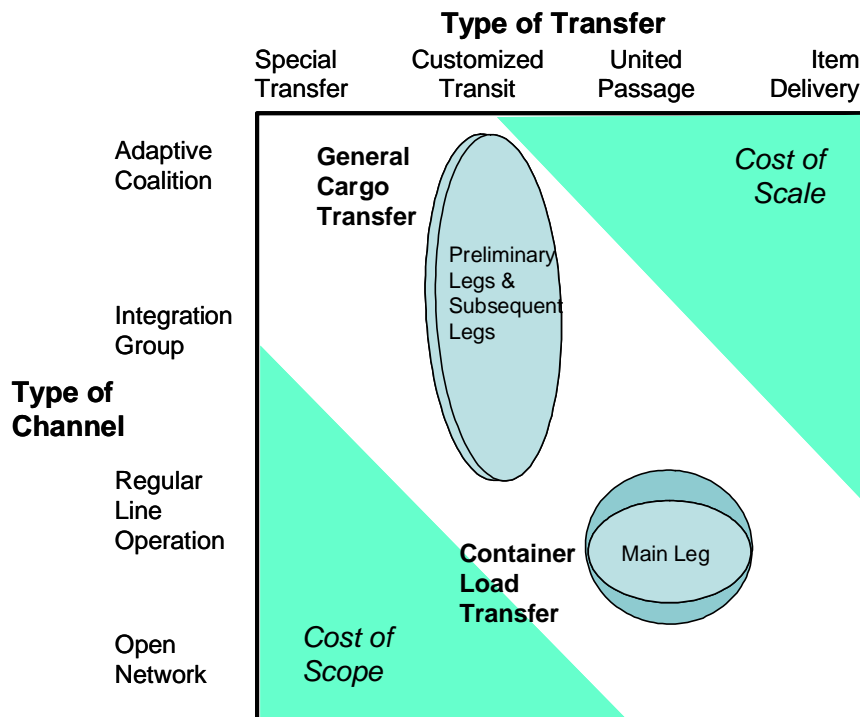
Questions considered also the scopes of the alternative portfolios of future container transportation chains. These were defined based on the number of the transportation stages of containerized cargoes. The alternatives given were: From port terminal to port terminal, from inland terminal to inland terminal, door-to-door and from production line to customer facilities. The same question was asked considering standard and special container transport in order to find out if the interviewed determine that these service offerings need to be separated in the future. In *basic container transport service* (standard) use is made of standard containers and the services/chains do not include special arrangements or extensive planning during the transportation process. In *special transport service* (special) special arrangements during the door-to-door transport are required and these arrangements can be related to one or several stages of the chain. These may include reefer unit – electricity required, open-top or open-side units - special location in the ship's cargo hold required, IMCO units – dedicated storage area and special documentation, terminal - special packaging requirements of the products, etc. According to the results, the door-to-door container chains and from production line to

customer facilities are going to be the dominating types of container chains whereas shorter container chains tend to loose in significance (Figure 4-13). Similar general prediction is widely presented in the literature however not maybe so clearly addressed and classified. The interviewed also made a relatively clear distinction between standard and special container transport service.



**Figure 4-13** The Container Transport Chains of the Future (Bask and Laine 2000)

Elementary in intermodal transportation is that the same unit is moved in different transportation phases. In traditional sea container transportation between port terminals this feature is not utilized. In maritime shipping the productivity and other gains from containerization have been enjoyed in ship cargo handling (more generally in modal changes) and in the internal moves at port in terms of less labor required, faster turnaround of the ship, easier and more secure handling of cargo with reduce damages, etc. They together with the sea transport represent the ‘United Passage’ and, as in the following the transportation chain is divided into ‘preliminary legs’, ‘main leg’ and ‘subsequent legs’, the mentioned operations are included in the ‘main leg’. The transportation chain of general cargo in port terminal-to-port terminal FCL (Full Container Load) transfer is presented in the Figure 4-14.

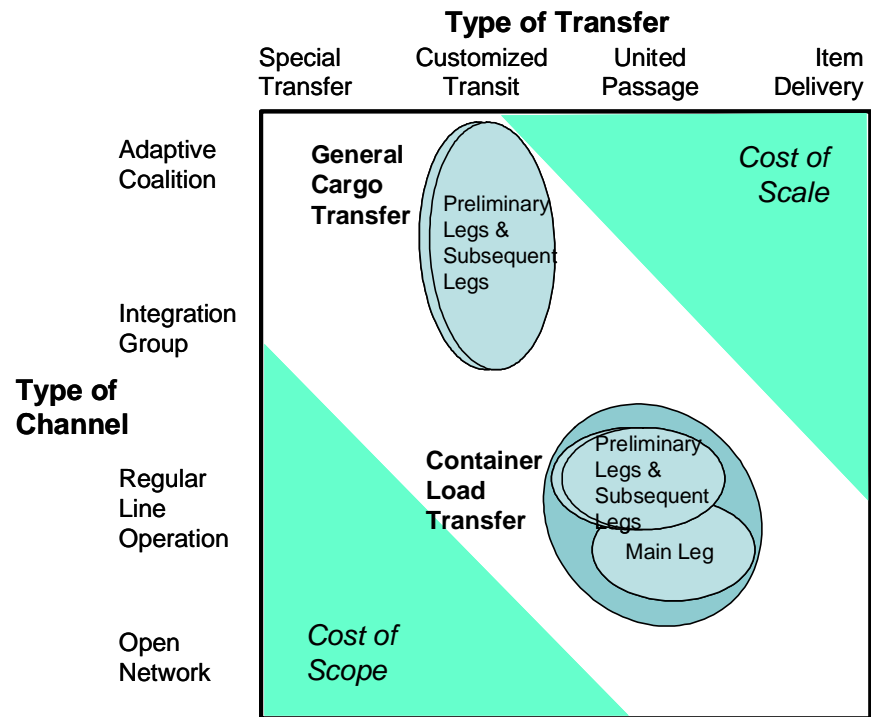


**Figure 4-14** General Cargo in Port Terminal-to-Port Terminal FCL Transfer

In the preliminary stages ('Preliminary legs' in the figure) the loose or palletized general cargoes have arrived from the shipper - typically by truck or train - to the port terminal, where the cargoes are stuffed and containerized. Respectively after the main leg during the 'Subsequent legs' similar stages have taken place in the opposite order - the containers have been stripped at the port terminal and the loose general cargo transported further by truck or train (or by inland vessel) to the consignee.

Inland terminals in domestic traffic can be used for cargo consolidation, cross docking and related temporary stocking. The benefits are the shorter transfer distances compared to direct delivery in the collective transport phase and therefore more efficient use of the dedicated carrying capacity, higher frequency of service achieved and better utilization rate of carrying capacity in the haulage between terminals, and finally again efficiency in the delivery phase achieved due to use of appropriate capacity. General cargoes that are to be exported can be consolidated and/or containerized already in inland terminals as well. The share of 'United Passage' type (ideally supplied by 'Regular Line Operation')

is increased and correspondingly the share of ‘Customized Transit’ type is reduced in such a transfer chain. In Figure 4-15 is shown that part of the Preliminary and Subsequent Legs are included in Container Load Transfer. The efficiencies are achieved both in the collective transport and distribution of general cargo and in the terminal haulages (pre-carriage and on-carriage) of containerized cargo. This applies especially for the groupage cargoes (LCL, Less than Container Load) of container transportation.

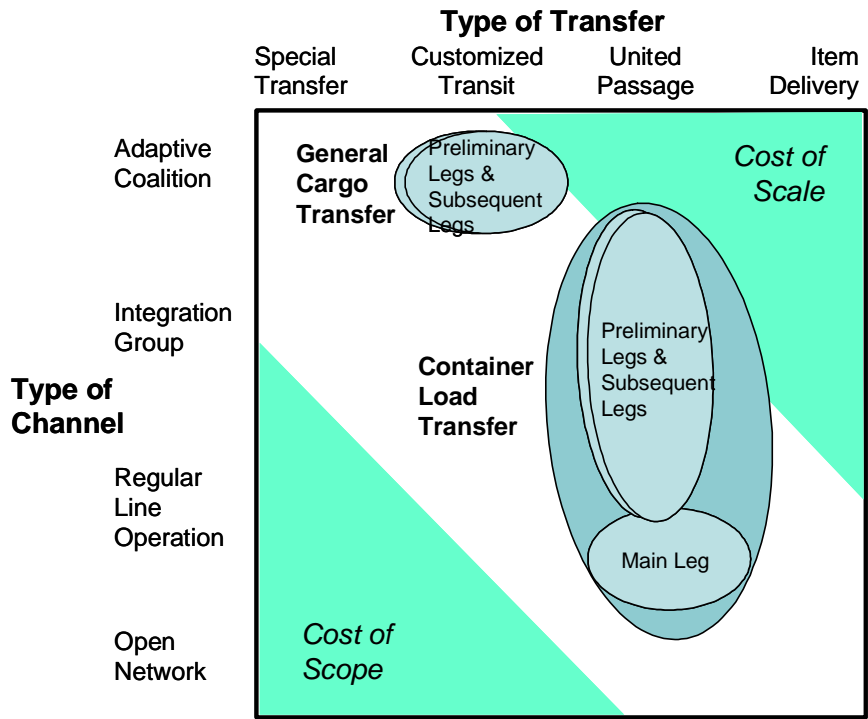


**Figure 4-15** General Cargo in Terminal-to-Terminal FCL Transfer

In order to further reduce the need to touch and handle cargo within the transfer chain, it is possible to expand the containerization closer to the shipper/consignor and consignee (Figure 4-16). In door-to-door container transfer most of the chain - from the shipper shipping point to the consignee receipt area - is of the ‘United Passage’ type. The part of the transfer remaining as general cargo handling - or is the type of ‘Customized Transit’ - are the transfer phases that occur within the shippers facilities on the other and in consignees facilities on the other end. The efficiencies (together with other benefits like reduced damages) are achieved from the unified and speedy modal change that

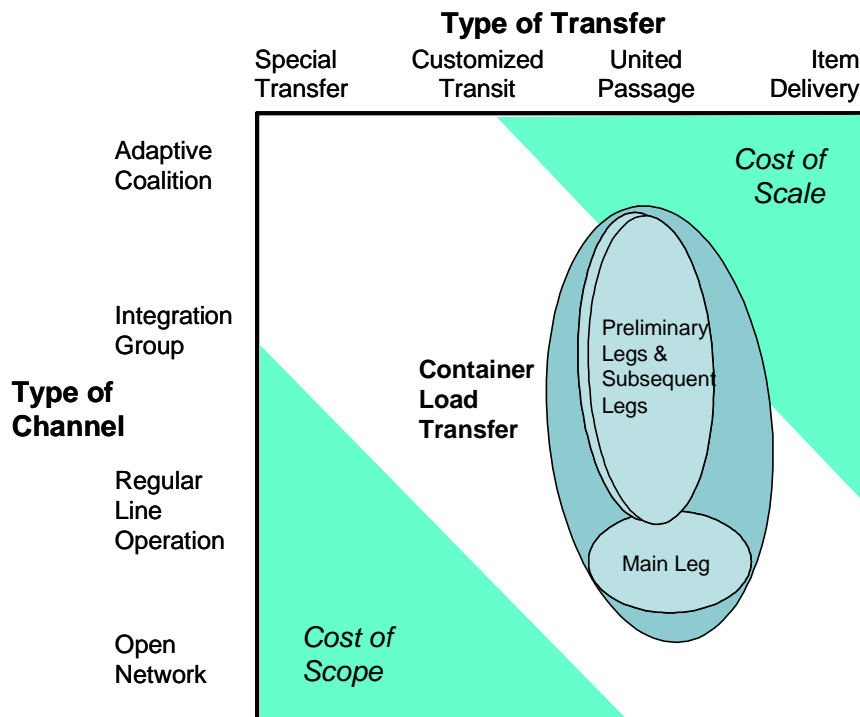


substitutes the time consuming cargo handling. This applies especially when significant volumes of FTL containerized cargoes are transferred directly from shipper to consignee presumably over long distances (e.g. overseas traffic) where also economies of scale in reduced freight charges is a clear benefit.



**Figure 4-16** General Cargo in Door-to-Door FCL Transfer

One stage of cargo handling is practically eliminated and the need to touch the cargo is minimized if the cargo is containerized directly in the end of the production line (or in the loading point of the production warehouse) (Figure 4-17). It may be difficult however to find product categories and transfer needs that allow immediate containerization without need to transfer the goods within the production facilities e.g. for preparation for transportation, temporary stocking etc. On the other hand this may be the most efficient approach for containerized cargoes especially in the case of demand driven production and delivery.



**Figure 4-17** General Cargo in Production Line-to-Customer FCL Transfer

A general challenge of increasing the scope of containerization within the transfer chain is that the longer the containerized part of the chain is, the more demanding it might be to balance for efficient operation in both directions. The challenge is likely to grow if the production or delivery process runs without need for containerized supply (e.g. raw materials) or if the scheduling is difficult to adapt with the demand. In that case empty containers are required for the transport of shipper's goods. In many cases the positioning challenges of empty containers may ruin the economy of the otherwise feasible transfer entity.

## 5 Transfer Performance of a Shipping Company

This chapter is based on an article published in *International Journal of Physical Distribution & Logistics Management*, vol. 24, number 8, 1994. Jouni T. Laine, Ari P.J. Vepsäläinen “Economies of Speed in Sea Transportation”.

Investing in large ships has been the traditional way of increasing the capacity of cargo transportation and raising the profitability of shipping through higher freight income. The economies of scale have been achieved, however, at higher fixed costs and higher operational risks because of fluctuating demand for transportation services. A more flexible way to increase the cargo carrying capacity is to raise the cruising speed by improving ship hull design and engine power, resulting in a higher number of round trips per year. The additional benefit of higher frequency is faster delivery and responsiveness of customer service, implying also the possibility of charging higher freight rates. The fast ship projects have, unfortunately, a history of failures due to excessive fuel costs and problems in congested ports.

There is, however, another way to achieve economies of speed in sea transportation by improving cargo handling facilities and loading speed. Considering its potential benefits, cargo handling speed has received much less attention in practice and in the literature of shipping economics than the perhaps more glamorous developments in naval architecture. There also the development of technology trespasses the territories of several organizations whose interests and business processes are more difficult to align than the mere physical structures.

This part addresses the opportunity to add value by increasing the loading speed. First the goal of improving capital utilization and cargo-carrying capacity via frequency of shipping service is analyzed. Since the investments in ship size, cruising speed and loading speed are interrelated; their tradeoffs are traced starting from the traditional operations and extending to the opportunities offered by new technology. The results indicate that there is untapped profit-making potential in port operations highly relevant for the practicing shipping companies. Second, the issue of variable costs and fees charged by stevedoring companies is discussed. In considering the development of cargo handling technology, the shipping company may either use automated container terminals

(already operating in Rotterdam and Singapore) and hatchless ships or opt to reduce its dependence on port facilities and services. We study the savings achieved, for example, by the use of a self-discharging ship.

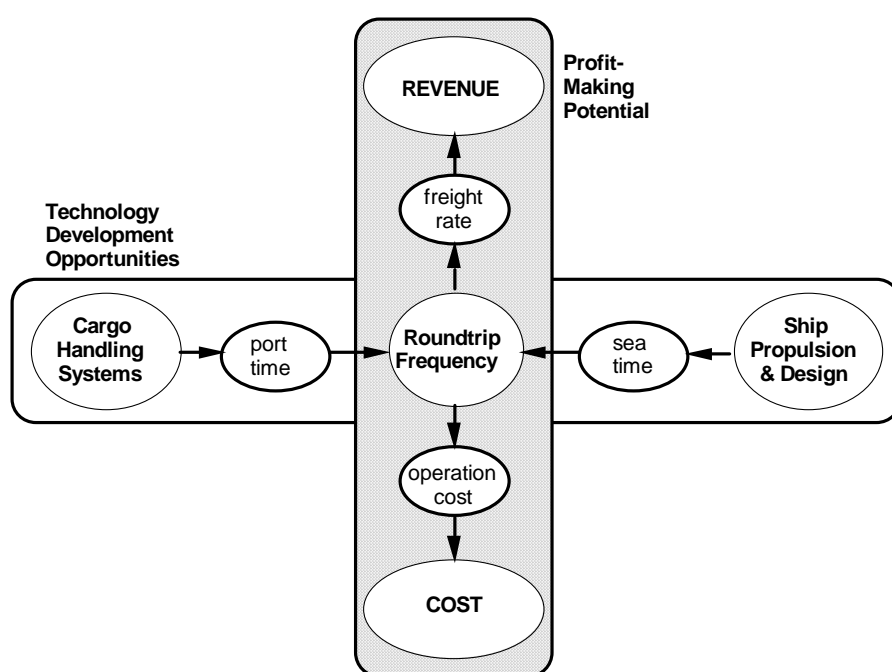
The gist of this chapter can be illustrated with an analogy drawn from Japanese manufacturing applied in shipping. The traditional working methods (lashing, stevedoring, etc.) still in use require specialized workers and obscure the opportunities for standardized process support. The idea is to distinguish *internal set-up* (performed only when a machine is shut down) from *external set-up* (done while the machine is running). The possibility to apply methods to reduce the unproductive machine time by manipulating the two types of set-up has been pursued in the Japanese manufacturing systems since the 1950's (Shingo 1985). Similarly, the internal set-up times have been reduced in port operations by using standard containers. The question addressed here is how to fully realize the potential for set-up time reduction so as to revolutionize port operations as was done by the Japanese pioneers of just-in-time manufacturing.

The chapter is organized as follows. First a model of the impact of technology investments on the profit-making potential in shipping is provided. Then the tradeoffs between the cruising speed and the loading speed are illustrated with numerical examples including also ship size as a design variable. Next is the section concluding discussion followed by a section where is presented a simulated business analysis of a conventional container ship and a self-loading *Twinstar* (The Motor Ship 1987) design.

## **5.1 The Impact of Technology Investments in Profit-Making Potential**

The profitability of shipping business depends directly on freight income and operation costs. Both the income and costs are related to the amount of transported cargo that, for a given size of ship, is determined by the frequency of service, e.g. number of roundtrips on a given line per year. We call the difference between revenue from freight and operation expenses per trip the profit-making potential of the ship (see Figure 5-1). The central element of creating value in shipping is the roundtrip frequency that increases the income and decreases the unit costs by allocating the fixed costs, such as capital investments and labor costs, to a higher number of trips.

In further analysis of the ship's roundtrip, a distinction has been made between the “unproductive” time spent in port, in ballast, or off hire and the loaded days, the “productive” time, at sea (Stopford 1990). Our interest is in cutting down the total roundtrip time by some direct investments in shipping technology. Hence both the productive and the unproductive time are equally important in increasing the roundtrip frequency. We differentiate between two different types of technology investments, either in cargo handling systems or in ship propulsion and design (Figure 5-1).



**Figure 5-1** Technology Investment Opportunities for Economies of Speed in Shipping (Laine and Vepsäläinen 1994)

In the literature on shipping economics, the cruising speed of ship has been seen as the major factor in shortening the roundtrip time to increase the profitability of shipping or competitiveness of ship owner. The impact of turnaround time in port on the costs of a cargo liner has been analyzed by Goss (1965), but the role of loading speed and port time in increasing the freight income has not been given as much emphasis. The following references indicate the bias for designing faster ships.

'Faster vessels draw greater advantage from rapid turnaround in port than does slower tonnage. Raising loans finances most new tonnage. As a vessel of moderate speed makes more voyages a year than a slower ship, it can have higher revenue earning potential and thus a better prospect of meeting the capital charges. The faster vessel can make more productive use of the crew as it can make more voyages a year. High speed vessels can in peak periods run at high speed, while at other times they can operate at a lower speed. Two faster vessels are likely to produce a better investment return than three slower vessels' (Branch 1982).

'The value of the cargo is important because it influences the financial cost of transit time and hence the design speed of the ship. High-value cargoes incur a substantial inventory cost, so there are financial incentive to transport and store small quantities' (Stopford 1990).

'Another reason why higher speeds are often used in the liner trades derives from the conference system. Under conference rules, freight rates are fixed, and owners therefore compete for business by offering better service, one form of which is higher speed hence faster delivery of cargo. Even though the ship owner may expect to carry low value material, he may specify a higher design speed so that he will be able to complete more voyages during periods of high freight rates when he is making premium profits' (Stopford 1990).

The limitations in achieving very high cruising speed have been taken into account, however. 'Very high speeds are costly, not only because of the greater fuel consumption, but also because of increased engine size and weight, increased scantlings and length-to-breadth ratio of the vessel' (Evans and Marlow 1986). Some interest has been shown also towards port operations, but in a very aggregate level. Port time is taken as a whole without specifying how to cut it down. What should especially be noticed here is that cargo handling speed has not been mentioned in this context.

'There is intense competition between ports to attract cargo by offering advanced cargo handling facilities for containers, large bulk carriers and specialist product terminals. The provision of these facilities involves major capital investment in terms of civil engineering, cargo handling equipment and dredging. As a result, decisions about port

development depend crucially upon traffic forecasting to find out the volume of cargo, the way it will be packed and the ship types used. For example, the decision on whether or not to invest in a specialist container terminal involves such questions as: How much container cargo will be moving through our part of the coast? What volume of this cargo can we attract through our port? What facilities will we need to offer in future to attract this share of the cargo?' (Stopford 1990).

'It is very important to attain maximum efficiency, above all in ship turnaround time, and to ensure that port activities are carried out smoothly and do not constitute an impediment in the overall transit operation' (Branch 1982).

However, technology investment in more effective cargo handling system or higher cruising speed often results in better income through higher number of roundtrips and possibly in higher freight rate. In addition, decreased operational cost may be achieved for example by investing in a self-loading ship with lower charges for port services. Although in some large ports the operations of container terminal have been automated it is not possible to adopt these solutions in most ports, especially in the smaller ones. Despite the possibility of cutting down operating costs by introducing "lashing machines" and hatchless vessels, there will be the problem of ships being dependent on the use of the specific port. While changes are underway in some of the world's main terminals, here is also addressed some alternative ways of manipulating the trade-off between the cruising speed and cargo handling speed without unduly limiting the routing possibilities of the ship. In shipping business the role of high cruising speed is present in the decisions made by the management. Even other valuable features in the ship design might be lost because of the hunt for higher and higher speed at sea.

## 5.2 Illustration of Investment Tradeoffs

### 5.2.1 Model for Comparing Loading Speed and Cruising Speed

The numerical examples of the tradeoffs are based on the following two equations describing the roundtrip time (Equation 1) and transportation frequency (annual number of roundtrips, Equation 2 in case of two ports). This simple model hence supports the evaluation of the profit-making potential in shipping.

#### Equation 1 Roundtrip time

$$t = 2\left(\frac{d}{v} + \frac{2Q}{r}\right)$$

#### Equation 2 Transportation frequency

$$n = \frac{A}{t}$$

where	$t$	= Roundtrip time [h]
	$d$	= Distance between ports [nm]
	$v$	= Ship speed [knots]
	$Q$	= Capacity [TEU]
	$r$	= Rate of cargo handling [TEU/h]
	$n$	= Number of roundtrips per year (roundtrip frequency)
	$A$	= Annual operating time [h]

The two components of the roundtrip time are sea time and port time. The sea time depends on the ship's cruising speed  $v$  and the distance between ports  $d$ . The port time depends on the cargo handling speed  $r$  and the amount of cargo transported, here indicated by the capacity of ship  $Q$ . Especially should be noticed that the port time has a double effect compared to the sea time. This is due to the loading and unloading of cargo in each port that amplifies the impact of loading speed changes on the roundtrip frequency especially in shorter routes. The ship may also need time for maneuvering,



mooring and paper routines thus increasing the port turnaround time not accounted for here. In a congested port the ship may also have to queue for crane service or to wait for the cargo. The annual operating time,  $A$ , is at most  $365 \times 24$  hours, but in practice it is reduced by the days the ship is out of service for e.g. maintenance, or other reasons.

The model presented in Equations 1 and 2 can be used to compare the impact of alternative investments in cargo handling and ship propulsion on the economies of speed of the ship. It also supports the decision in assigning ships on alternative routes.

### **5.2.2 Alternative Technology Investments for Economies of Speed**

In the following, two investments in cargo handling and ship propulsion are compared by analyzing hypothetical cases in container shipping. A suitable measure of performance is the reduction of roundtrip time and the resulting increase of the number of annual roundtrips.

More specifically, the following alternative modifications are considered for an original design of a 1000 TEU container ship with a cruising speed of 20 kn (relatively high in shortsea shipping) and moderate loading speed of 30 TEU/h (using port cranes) that is intended for a Coastal Europe Shortsea Route (2000 nm roundtrip; see Figure 5-2). For simplicity in the calculations the ship is loaded with 20-foot containers meaning that one lift is equal to one TEU. We have assumed that the extra investment in both cases would be USD10 Million.

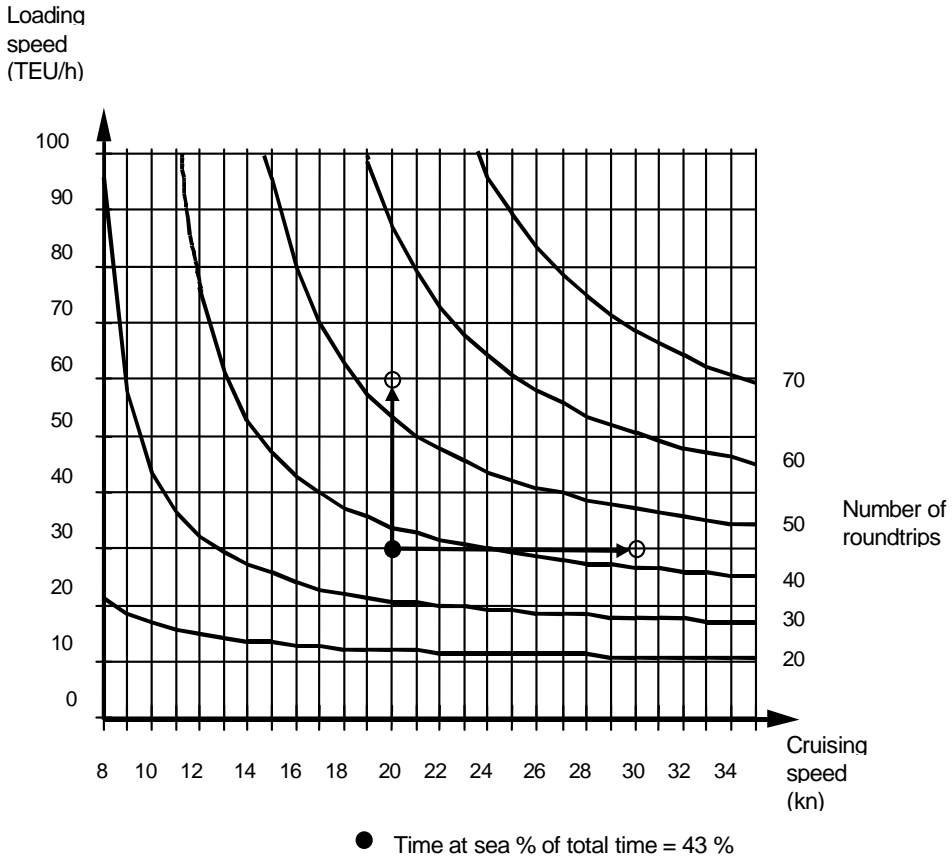
1. *Fast Ship design* Investment in faster cruising would increase the speed to 30 kn, giving 50% improvement. The performance in number of roundtrips would improve from approximately 37 to 43, or by 17%. The terminal and other supporting services could be maintained at the preplanned level.
2. *Self-Loading design* Investment in faster on-board loading facilities (including three automated bridge type cranes of 20 lifts/h capacity) would increase the speed to 60 TEU/h, giving 100% improvement. The performance in number of roundtrips would improve from approximately 37 to 52, or by 40%. Furthermore, the ship would be less depending on port facilities and could avoid the cost of certain cargo handling services.

The investment of USD10 Million is here estimated to increase the cruising speed by 50% (a highly optimistic estimate) and the cargo handling speed by 100% (a more realistic estimate based on quotations from shipyards and crane manufacturers; see also section Case *Twinstar*).

### **5.2.3 The Trade-Off between Loading Speed and Cruising Speed**

The relative improvement of performance is greatly affected by the route length that alters the relative share of port time vis-à-vis sea time. In a relatively short route illustrated in Figure 5-2, investing in efficient automated cargo handling is more efficient than investment in ship propulsion. Higher transport frequency can be achieved often with an additional benefit of lower operational costs due to the savings in stevedoring expenses. In the Figure, the isoquants indicate the feasible roundtrip frequencies in terms of different loading and cruising speeds.

The dot represents the traditional design as a starting point, while the circles indicate the improvement achieved by each of the two alternative designs. In the traditional case, the share of the total time spent at sea would have been only 43% and time spent in port 57%. This means that the same percentage decrease in port time compared to sea time has twice the effect in the total roundtrip time. The traditional cargo handling speed is estimated as a long time average in congested ports with one or two cranes available for servicing, including queuing and set-up time, removing hatches, and other delays. The Self-Loading design would have at least three or even four cranes and it could avoid many of the delays in port.



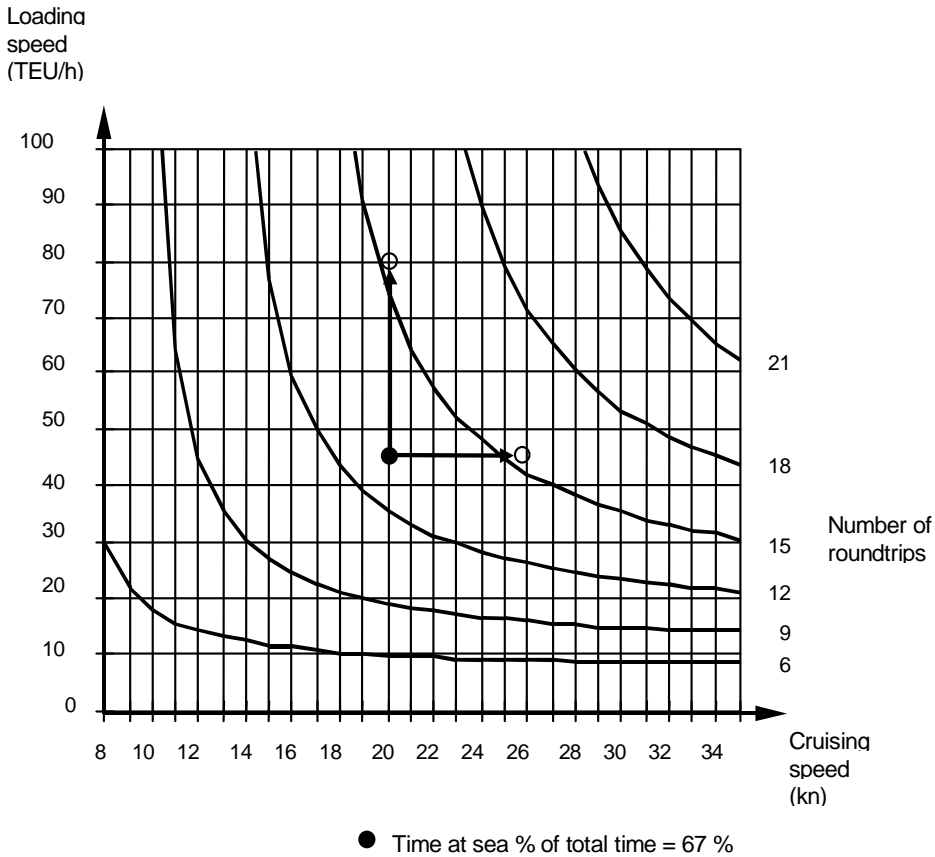
**Figure 5-2** Service Frequency Curves as a Function of Loading Speed and Cruising Speed - Coastal European Shortsea (Route 2000 nm), 1000 TEU (Laine and Vepsäläinen 1994)

Increasing the cruising speed by the Fast Ship design is expensive due to the physical laws of propulsion according to which the power requirements rise extensively with the cruising speed. In addition to the investment in propulsion equipment, this means high fuel consumption (Evans and Marlow 1986). On the contrary, there are no significant physical limitations to increase the cargo handling speed although more expensive terminal facilities and high speed cranes may be needed. The extreme points on the axes in Figures 5-2 and 5-3 correspond to the limits of 35 knots cruising speed of for example the Euroexpress-type ship. (Euroexpress is a brand name for a high speed ship concept

designed by Kvaerner Masa-Yards) and three or four cranes of 20 to 30 lifts per hour each (considering the possibility to lift two TEU's at a time). However, it may be impossible to combine these extreme capabilities in one design.

To recapitulate, the time spent at sea would be as low as 40% of the total time on the route if a large ship is served by one crane only or in a public terminal with slow operation, or as high as 80% if a slow small ship is operating between two own terminals with increased cargo handling speed.

In comparison, the analysis of a longer route in the case of a 2500 TEU ship on a Trans-Atlantic route (Figure 5-3) indicates a different trade-off between cruising speed and loading speed. Assuming for the traditional design in over-seas traffic moderate the cruising speed of 20 kn and moderate loading speed of 45 TEU/h, the resulting share of the time spent at sea would be 67%. The Self-Loading design could achieve loading speed of 80 TEU/h using four parallel cranes, improving the performance from 13 to 15 roundtrips a year, or by 15%. The corresponding improvement by the Fast Ship design could be achieved by increasing the cruising speed to 26 kn. One can now, in this hypothetical case, compare the investments required for both designs to get the same service frequency, also keeping in mind the impact on operation expenses of the different designs. Similarly, one could consider any combination of improved cruising speed and loading speed, along the estimated investments, in order to find the most efficient new design.



**Figure 5-3** Service Frequency Curves as a Function of Loading Speed and Cruising Speed - Trans-Atlantic (Route 9000 nm), 2500 TEU (Laine and Vepsäläinen 1994)

#### 5.2.4 The Impact of Ship Capacity

The trend to increase ship size has been driven by the pursuit of economies of scale. The larger the ship, the lower are the fixed costs (and most of the variable costs) per unit of transported cargo. Large ships may also utilize several cranes enjoying a higher cargo-handling rate. The growing ship size may also indirectly increase the economical cruising speed due to the decreased relative resistance of a larger hull. The total time spent in port

may be longer, however, for a large ship since the cargo handling rate doesn't increase proportionally to the cargo-carrying capacity.

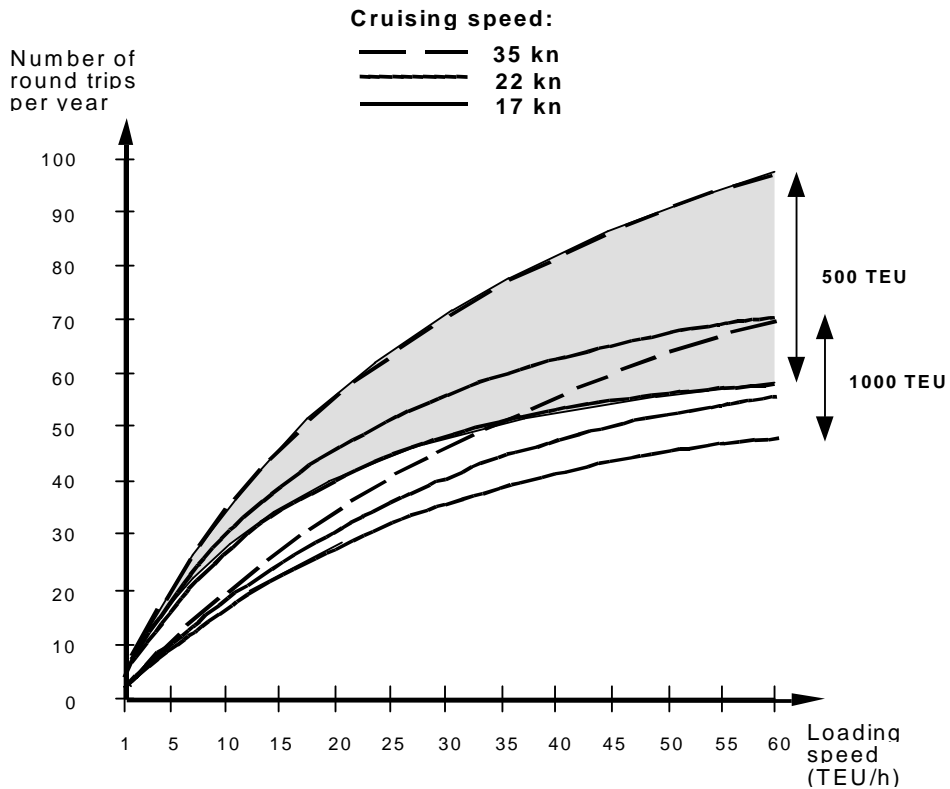
However, the trend towards smaller transportation batches may generate demand peaks that are difficult to predict. Fluctuating demand causes low utilization of the large ships and of port and land transportation facilities, while occasionally leading to congestion in ports as thousands of containers move in and out of a port area in a matter of hours (Levander 1993). In ports with direct hinterland connections the growing ship size is likely to have even bigger consequences than in hub ports since for example already one 2000 TEU ship arriving requires ten trains carrying 200 TEU's each or 500 trucks each carrying four TEU's to be available and maneuvered at the terminal. In this sense the view of Cullinane and Khanna (1999) in their investigation is difficult to accept in other settings than between hub ports (in deep sea shipping) – besides their impressive voyage cost analyses they found inappropriate to model door-to-door costs '...since the additional costs that such an approach implies are unaffected by economies of ship size in container shipping'. It is possible to organize container handling in port to allow very high traffic rates, but there are several problems involved in the optimization of the service facilities and scheduling of congested queuing networks.

The length of the route naturally affects the optimal ship size. In short routes larger ship size causes a relatively longer waiting time in port leading to low capital productivity, low customer responsiveness and lost freight income. The investment in a larger ship is also riskier because of the fluctuations in the demand for transportation services. During low demand it may be difficult to maintain high utilization rates or move the ship into more profitable routes because of the specific technical requirements in terminals.

Another constraint imposed by liner shipping service is the timetable to be followed. The capacity of the ship should be chosen so as to balance the need for high service frequency - giving the advantage to smaller ships - and the scale economies of larger ships providing lower operational costs per unit of cargo.

In the interest of a faster service, the impact of ship size can be analyzed on the basis of the trade-off between cruising speed and loading speed studied above. Since a small ship with a fast cargo handling system spends less time in port, it is also in a better position to

leverage the high cruising speed. This fact is demonstrated by the shaded area in Figure 5-4.



**Figure 5-4** The Leverage of High-Speed Loading in Service Frequency Achieved by Higher Cruising Speed for Ships of 500 and 1000 Capacity (TEU), 2000 nm Route (Laine and Vepsäläinen 1994)

The curves indicate the roundtrip frequency for two ships of 500 TEU and 1000 TEU capacities with different cruising speeds (from 17 kn to 35 kn) as a function of the loading speed. Given a loading speed of 30 TEU/hour, the increase of cruising speed from 17 kn to 35 kn for the smaller ship adds 49% (from 48 to 71) to the number of roundtrips per year whereas the larger one only gets 32% (from 35 to 46) improvement. What is more impressive, doubling the loading speed to 60 TEU/hour further leverages

the higher cruising speed by increasing the number of annual roundtrips by 67% (from 58 to 97) for the smaller ship and only 49% (from 48 to 71) for the larger one.

In this case, maintaining a high line frequency with a larger ship, both cruising speed and cargo handling speed need to be increased significantly. On the other hand, by investing in faster cargo handling facilities on a smaller ship the shipping line can provide the same annual cargo-carrying capacity as with the larger one. For example, the loading speed of 60 TEU/hour for a 500 TEU ship can maintain 70 departures a year, twice the frequency of a 1000 TEU ship loading at regular 25 TEU/hour when both ships are cruising at 22 knots (see the middle lines in Figure 5-4). With the regular loading speed, the same response time would require a cruising speed of 35 knots which is hard to reach for current cargo ship designs.

However, a new design of equally fast (35 knots) ferry proposed for a 1200 nm route within the Baltic Sea in the Euroexpress project seems to support the above reasoning. With its moderate (140 trailers) cargo-carrying capacity, this concept decreases also the loading time so as to fit the roundtrip within two days. The investment in an Euroexpress ship would be at same level as in two conventional ships of the same annual transport capacity. Some additional investments in loading ramps and other port facilities would be needed. In the Euroexpress project, a complete redesign of the whole ship is proposed to capitalize on both the opportunities of technology in propulsion and cargo handling. The small size and high cargo handling rate lead to high share of sea time that leverage the high cruising speed. The operation costs will be increased, however, due to significantly higher fuel consumption that has to be compensated for by a higher freight rate to achieve an economical operation.

### **5.3 A Framework of Shipping Economics**

Finding the most economical combination of the size, cruising speed and loading speed of a ship on a given route is a problem not often addressed by academic studies or by shipping companies. It is indeed an intricate question of balancing the investments in shipping technology and targeting the development efforts. Large ships may increase the capacity of cargo transportation but suffer from longer relative port time, poor respon-



siveness to customer needs and low capital productivity under low demand. Hence the improvement of performance should be sought from increasing the roundtrip frequency of ships. Higher frequency can be achieved by developing either the ship propulsion and hull design or the cargo handling system. As our analyses show, investment in cargo handling may yield a remarkably higher return than in ship propulsion at the current level of shipping technology. Additional savings in operation costs may be achieved if the ship is of a self-discharging type. In addition to the relatively simple model also a wider frame of the parameters and variables influencing to the shipping company's investments decision-making is presented.

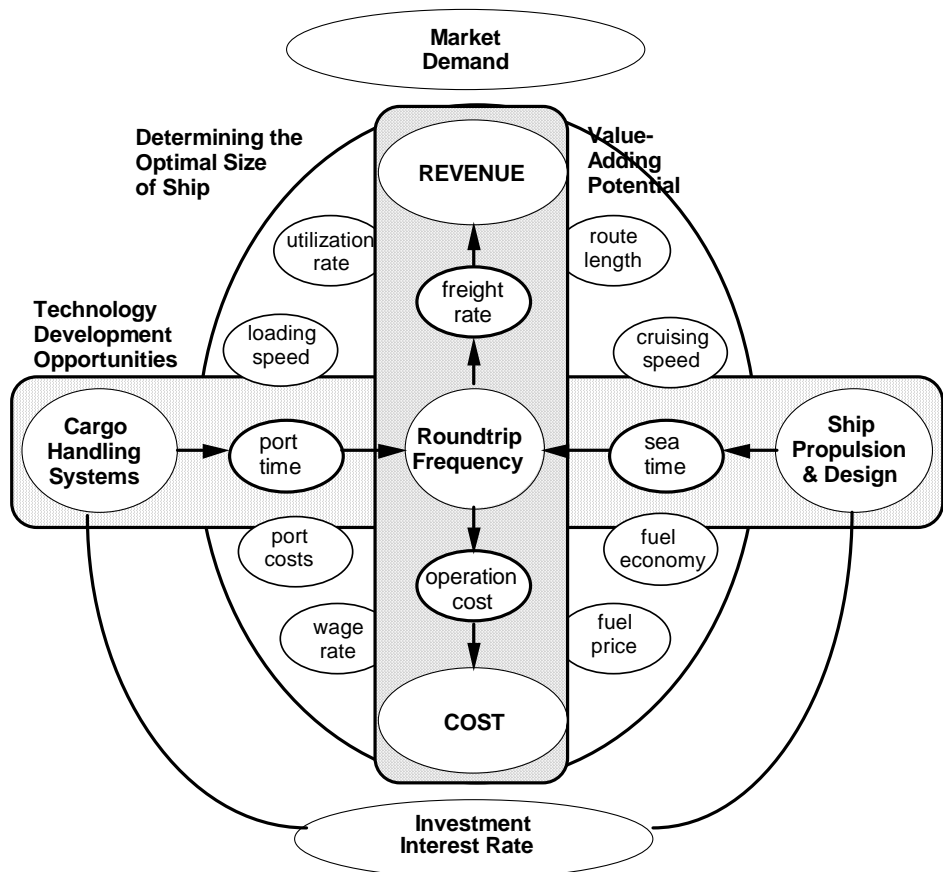
How has this kind of potential for savings and better service gone almost unnoticed by the managers and scholars alike? There is both the resistance to change and the underestimation of operational improvements. Shipping companies lack the bargaining power and control of port development limiting their experimentation with new solutions. Innovations may also have been hindered by some other factors, including:

- Required investments to port facilities, cranes and terminals
- The negotiation power of port management and service providers
- Conservative political attitudes and resistance to change by unions
- Imperfect competition due to government subsidies
- Long lasting recession in shipping industry
- High perceived risks of a novel solution

In Europe, for example, the structural dynamic has been increasing due to the deregulation of transportation, new competition (e.g. Channel Tunnel) and new market areas (Eastern Europe). Legal barriers to market entry are being pushed into the background and increasingly substituted by economic factors. It has been suggested that in the future, the transportation structure will follow the evolving business strategies rather than the reverse (Bukold 1993).

The concepts of Profit-Making Potential and Technology Development Opportunities capture some essential features of the ways to achieve economies of speed in the business of container shipping. There is a multitude of other variables and conditions to

be taken into account in a sound optimization to support business analysis. The framework in Figure 5-5 illustrates the most important variables to be considered in shipping economics.



**Figure 5-5** Framework for Technology Investments and Economies of Speed in Shipping (Laine and Vepsäläinen 1994)

The variables have different direct and indirect influences to revenue and costs affected not only by the investments of the shipping company but also by competition and market situation. Investment in cargo handling systems, for example, may reduce labor requirements and port costs in addition to increasing loading speed, which, due to price sensitive demand and resulting higher utilization rate, provide the foundation for profitability in container shipping. Similarly, by developing the ship propulsion it is possible to affect cruising speed and fuel economy. The impact of the variables may

contribute on both the revenue side and the cost side as well. Route length, for instance, increases fuel consumption and operation costs while it also may influence the revenue through increased freight rate.

Ships arriving at random cause fluctuating need for port facilities and services. Thus the port may incur both overage cost (excessive capacity and low profitability of port investment) and underage cost (lack of capacity, lost income and long queuing time for the ship). The problem is that the port investments have long life time and they are fixed to a geographical location. Therefore the capacity is difficult to balance with the shifts in demand in the long run. Shore investments, such as berths and handling equipment can prove very costly, particularly if a special purpose vessel requiring capital intensive facilities is to call at several ports (Branch 1982).

In principle, for the port operator congestion of port ensures high utilization of terminal facilities. The risk however is that potential customers are scared away. Also, the ship owner may only be interested in port operator's overall cost to the extent it leads to higher fees being charged. For the end customer (shipper or consumer), who finally pays the activities, the reliability of the delivery is important in addition to the cost and delays of the service. Hence all the parties could find mutual benefits in cooperative solution of the problems encountered. Close contacts should be maintained at all times among the port authority, shippers, agents, customs, trade associations and inland transport operators in order to facilitate rapid cargo transshipment (Branch 1982).

These organizational, political and cultural aspects of the shipping business should be also counted for in determining the technology and size of ships. The specific conditions in the intended transportation market determine the most economical route lengths and port infrastructures. Finally, it is the question of the availability and price of capital as well as resourceful shipping entrepreneurs who determine the realization of the innovative shipping solutions and cargo-handling systems.

## 5.4 Technology Solution Case Study - *Twinstar*

### 5.4.1 Economical Implications

The importance of quick cargo handling has been noticed as a significant factor affecting the profitability of shipping. An interesting question is how the loading speed could be raised in practice to the levels indicated above. Two possibilities are either to invest in port facilities or onboard cargo handling facilities. In the following, the solution is based on the latter in the form of a self-loading container ship proposed by the *Twinstar* design (The Motor Ship 1987). Contrary to the earlier self-discharging ships the vessel consists of a fully-enclosed hull with automated storage facilities. The cargo is loaded astern by three or four overhead bridge type cranes moving over the full length of the vessel that make the ship independent of port cranes. The cranes are integrated to the hull structure thus causing minimum increase in weight and change in position of the center of gravity. Lloyds Register of Shipping has accepted the complete calculations and drawings for the *Twinstar*. It is similar to the proposed ship for paper product transportation by the Swedish company Ahlmark (Transport & Hantering 1992). The enclosed forest carrier *Grouse Arrow* delivered for La Tour Blanche Shipping Corporation shares many of the crucial features of *Twinstar* as well (JSEA 1993). Three crane manufacturers have made the drawings and calculations with price indications of the cranes proposed for the *Twinstar* design. The technology for cargo handling rates of 20 lifts /hour /crane is widely known.

Despite of the hatchless vessels with extended cell guides have eradicated the need for deck lashing, they are still dependent on shore-based cranes and the use may suffer of ice cover in icy conditions. “Lashing machines” may reduce operation costs but they do represent additional investments in terminals. From the cargo handling point of view the *Twinstar*-design is hatchless, independent of terminal cranes and the containers carried are protected from the weather.

In the following business analyses, the proposed *Twinstar* ship has been compared to a conventional container ship. The variables of the framework of the shipping economics outlined above are included in the simulations along with more detailed data on the shipping line and market conditions in question. Simulation results for the route Pori (Finland)-Hull (UK)-Rotterdam (Netherlands)-Pori are presented in Table 5-1.

The characteristics of the line are the following (for simplicity is assumed that the ship carries only 20-foot containers):

Roundtrip length: 2331 nautical miles (1137+208+986)

Average speed: 18 knots

Freight rates: \$450 (Pori-Hull), \$450 (Rotterdam-Pori)

Utilization rate: 0,75 (Pori-Hull and Rotterdam-Pori)

**Table 5-1** Performance of Self-loading Twinstar (TWS) and a Conventional Container Ship (Cont.) - Comparative Simulation Results

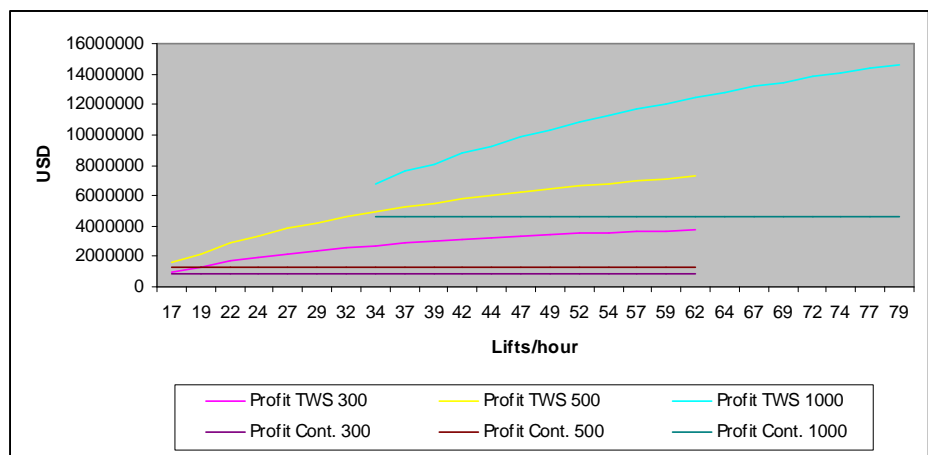
	300 TEU		500 TEU		1000 TEU	
	TWS	Cont.	TWS	Cont.	TWS	Cont.
Price of the ship (\$M)	35	25	40	30	60	50
Cargo handling (TEU/h)	60	17	60	17	80	34
Roundtrip time (h)	153	211	168	265	187	265
• Sea	130	130	130	130	130	130
• Port	23	81	38	135	57	135
# roundtrips per year	57	42	52	33	47	33
Fixed costs/TEU	196	216	164	216	146	186
Variable costs/TEU	110	186	103	183	94	171
Total costs/TEU	306	402	267	400	240	357
<b>Profit (\$M)</b>	<b>3.7</b>	<b>0.9</b>	<b>7.2</b>	<b>1.2</b>	<b>14.7</b>	<b>4.6</b>

The cargo handling rate of 17 lifts/hour for the conventional ships (300 and 500 TEU) is the average of six ship calls in the Saukko Quay of the Helsinki West Harbour in an investigation in spring 1988 (Esko Poltto Oy 1988). For simplicity it is assumed that one lift equals one TEU, in many practical cases however one lift = 1.5 TEU is more

applicable. Later investigation gave a 20 lifts/hour average. The increase was at least partly caused by investments into more efficient cranes (Vuorinen 1998). It is assumed that a 1000 TEU ship can utilize two cranes. This is supported by the survey of Cullinane and Khanna (1999) where was revealed that, on average, just over one crane is used for ships less than 700 TEU and in the range of two cranes for 1000 TEU ships.

These results indicating three to six fold improvement of operational margins under quite conservative assumptions on capital costs, utilization rates and daily costs, suggest the *Twinstar* design as a competitive prospect for the line studied. The reason for higher profitability of *Twinstar* is the remarkably short port time and low cargo handling expenses provided by efficient and automated cargo handling. Additionally *Twinstar* is less dependent on port labor that reduces its sensitivity to higher fees charged in ports in nighttime and weekends. Fast turnaround leads to higher freight income most of which is directly translated into the profit margin. Also more detailed information is given for the fixed, variable and total costs calculated per TEU transported for the three different sizes of ships. The saving per unit is easily achieved from these figures. For example for a 1000 TEU ship the saving was 117 \$/TEU - the cost was 240 \$/TEU for *Twinstar* compared to 357 \$/TEU for the conventional ship.

The results of additional sensitivity analyses made for the three different ship sizes and different cargo handling rates are shown in Figure 5-6.



**Figure 5-6** Twinstar Profit Sensitivity for Cargo Handling Rate and Ship Size

In the sensitivity analysis the cargo handling speed has been kept constant for conventional ship (17 lifts/hour for 300 TEU and 500 TEU ships and 34 lifts/hour for 1000 TEU ship) - horizontal line in the figure - but varied for *Twinstar*. If the cargo handling speed of *Twinstar* is for some reason reduced, the profitability dramatically deteriorates. However for the two smaller ships the profit is higher compared to conventional ship even with as low as 17 lifts/hour cargo handling rate total or less than 6 lifts/hour rate per crane. This is due to the reduced charges of port services.

The relative advantage of *Twinstar* in cargo handling speed compared to conventional vessel is relatively smaller the bigger the ship size. However the economy of bigger *Twinstar* is less sensitive for changes in cargo handling speed. This is seen in the relatively slower reducing profit of the 1000 TEU *Twinstar* in the selected route.

#### **5.4.2 Structural Implications**

Twinstar type of ship designs are at their best in business environment which attracts container traffic, but where the port infrastructure is less developed and no significant investments are going to take place. However such ships could call ports of higher standards as well. In that case some of its features may not be fully utilized and thus the relative advantages compared to conventional vessels may be partly lost.

On top of the direct economical influences Twinstar technology is an integrator between actors. The technology investment partly removes one interface and is therefore also transferring the interface between parties. This means change in the responsibilities both in ownerships and organizational wise (Figure 5-7).

<i>Organization</i>	<b>Shipping company</b>	<b>Port operator</b>	<b>Stevedoring company</b>	
<i>Physical Structure</i>				

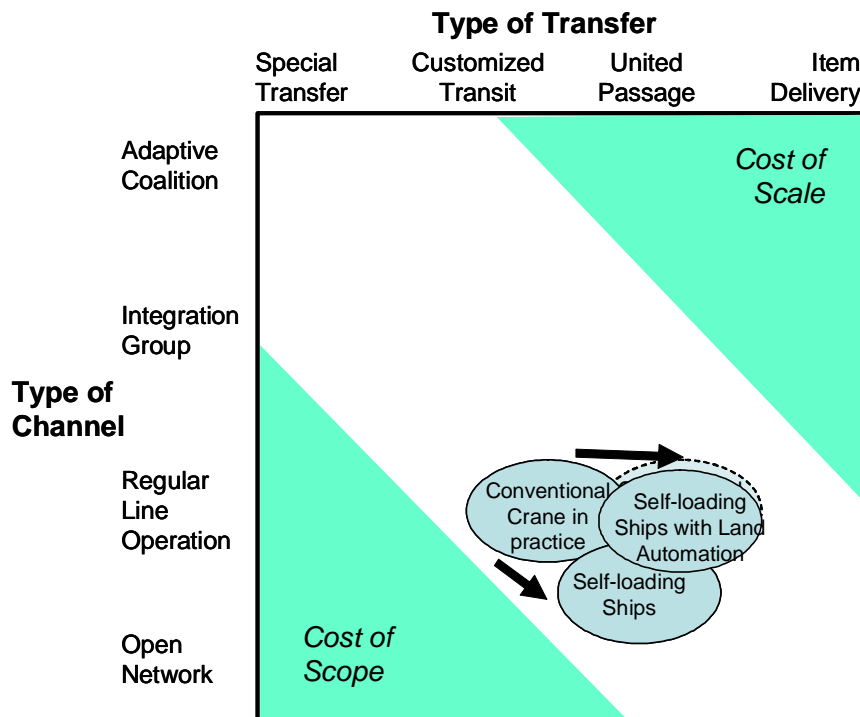
<i>Organization</i>	<b>Shipping company</b>	<b>Port operator</b>	<b>Stevedoring company</b>	
<i>Physical Structure</i>				

**Figure 5-7** Crossing the Interfaces - the Case of Twinstar Technology

As a result the traditional roles in the port surrounding would be changed and borders between parties involved will be weakened or even partly vanished. Especially this may speed up the development seen in some terminals where the port operator is less involved in the everyday operation and form to end up in a land lord -type role.

Self-loading technologies support more flexible seaborne transfer systems with lighter port infrastructure requirements. They also eliminate the need for port cranes, and the connectivity between sea transport and port operation stages are increased (Figure 5-8). The technology solution streamlines the ship-crane handling interaction by eliminating the barriers in this interface (set-ups are externalized and minimized). The cargo handling capacity is balanced with the cargo carrying capacity and e.g. dimensioning of port cranes in relation to ship dimensions are not any more relevant. Also there is one organizational interface less involved (with all the connectivity requirements).





**Figure 5-8** The influence of Self-Loading Technologies (and Secondary Cargo Handling Automation)

While such an integrated approach stabilizes the ‘sea side’ it may put even higher performance pressures to the secondary cargo handling compared to what with the conventional crane handling is experienced. Therefore in order to achieve the best performance out of the integrated technology it should be extended further in the land side. Conveyor belts or automated secondary handling crane systems for example have been suggested in the draft designs to facilitate the higher performance. However this is again a step backwards in terms of flexibility as illustrated also in the matrix.

## **6 Improving of Port Efficiency**

Efficient port operations are an elementary part of feasible seaborne trade and therefore all transfer chains that involve maritime transportation. This is supported with modern infrastructure and advanced organizational and technological structures. Besides boosting regional activity in some countries efficient ports play significant role in the overall national economies. According to relatively recent views (World Bank 2001A) three board forces are generating momentum for port reform in developing and industrialized countries alike: External forces of competition and technology from the shipping industry; the acknowledged financial and operational benefits of private participation in infrastructure development and service delivery; and the diversification and globalization of investors and operators in the port industry.

### **6.1 Port in Transportation**

Hackett (1994) concludes the driving forces in a port's success as follows: 'Demand for port-specific seaborne transportation is shown as being driven directly by provincial of regional economic activities, which themselves are determined by the future prospects for the world economic environment, national macro-economic performance, infrastructure investments and foreign direct investment.' Transportation analysis and identification of key product flows for individual countries enables to develop port routings that are likely to evolve from these flows.

This approach assumes the natural cargo flows drive the development of the structure and changing transfer service demand is reflected in the infra- and superstructure and services offered. The location of the production plant or the markets in relation to the port is important to the shipper. Together with other features like service frequency, flexibility, speed and punctuality of the delivery, reliability, freight rate, connections to other ports etc. port's attractiveness is defined. Ports however bring so big economic and political values (indirect service production, employment, area politics, taxation potential, etc.) that they have been established also in locations with less natural prerequisites. In many case government and municipal policy has supported such development by constructing channels, offering financing arrangements, reserving areas

for ports etc. This kind of non-market-driven planning may force shipping companies to accept the port to call despite of the operational disadvantages.

There are several factors influencing to the routing decisions of shipping companies. The material flows and types of cargoes available is the starting point. Elementary to the shipping company is that the cargoes are applicable with the features of transportation vehicles and equipment. In order to minimize transportation of empty containers import-export balance is beneficial. Capacity and location of transportation channels, roads, railways, airports and waterways with regulations e.g. weights, draught and other dimension limits are the next important issues. Availability of own or hired transportation vehicles and equipment (ships, trucks, planes, trains, containers, flats) and facilities and equipment in ports and terminals (storage capacities, cargo handling rates) are also basic prerequisites. Most of these properties can be turned into economic factors that guide the decision making. Considering ports the costs related to transportation distance and time, cargo handling, availability and price of services are important. The related pricing in collecting fees of pilot, stevedoring, bunkering etc from shipping companies also turn to be important.

Economic and technical aspects may direct the development of a port to structures that in the current and future market situation either force the cargo flows to follow certain channels or to be a source of financial risks. The container cargoes are transported in large transportation batches typically between big ports. The traffic is centralized because of the need for big investments to the port facilities (Abrahamsson 1982). This requires either organized feeder or connection transportation or leads to long wait times for customers. Because of barges and ships carry larger loads than rail or trucks, storage facilities are necessary at the port. The cargo received from trucks and rail cars is held until sufficient volume is obtained for handled effectively by barge or ship. Conversely when a loaded vessel arrives at port, the freight is unloaded, stored, and dispatched in hundreds of rail cars or trucks at some later date (Coyle et al. 1990).

The port facilitates transfer of freight from one transportation mode to another. In ship loading and unloading cranes are required for that. The investments are tied together so that the larger the ships, the bigger physical dimensions are required from the cranes. Therefore big cranes and terminals are built to places where high utilization rate and

scale effects can be achieved. Purpose-built ship-to-shore cranes require strengthening of the port bank to carry the weight of the cranes. Such technically advanced materials-handling equipment reduces unproductive port delays and enables water carriers and ports to remain economically viable (Coyle et al. 1990). For railroads and motor carriers terminals at the port have railroad sidings to handle inbound and outbound rail freight as well as offer parking lots for motor carrier equipment (Coyle et al. 1990). Separate machinery is used for background cargo handling – to serve trucks and trains, move containers from storage areas to cranes, to make internal terminals moves, etc. Economical railroad transportation requires big transportation batches, which either come from one customer or more commonly have to be collected from several sources. Making the investments feasible required for railing, big cargo flows are needed. Truck transportation also may require development of the road network.

It would be beneficial if facilities at a port could be developed and operated in close coordination. Muller (1989) states that: ‘The future is likely to see a closer relation between sources of financing, shipbuilders, ship operators, shippers, consignees and ports.’ However according to World Bank (2001B) it should be emphasized that full control of the transport/logistics chain by one consortium (a global monopolist) is not a desirable development. Further ‘Because of regulatory measures by the United States and the European Union, the complexity of the transport/logistics chain and the number of players, a carrier’s ability to control of the full chain seems an illusion.’

An indication of the complexity is the following still valid observation registered more than twenty years ago. In many cases the coordination is still difficult even impossible because of one or more of the following conditions (Fair and Williams 1975).

- Lack of an adequate port authority which can plan and finance general improvements.
- Lack of modern wharves to handle general cargo.
- Absence of a belt line to make each wharf readily accessible to each railroad.
- Lack of adequate highway facilities including loading and unloading platforms at wharves.
- Absence of a wide marginal highway belt line along the waterfront reaching all wharves.

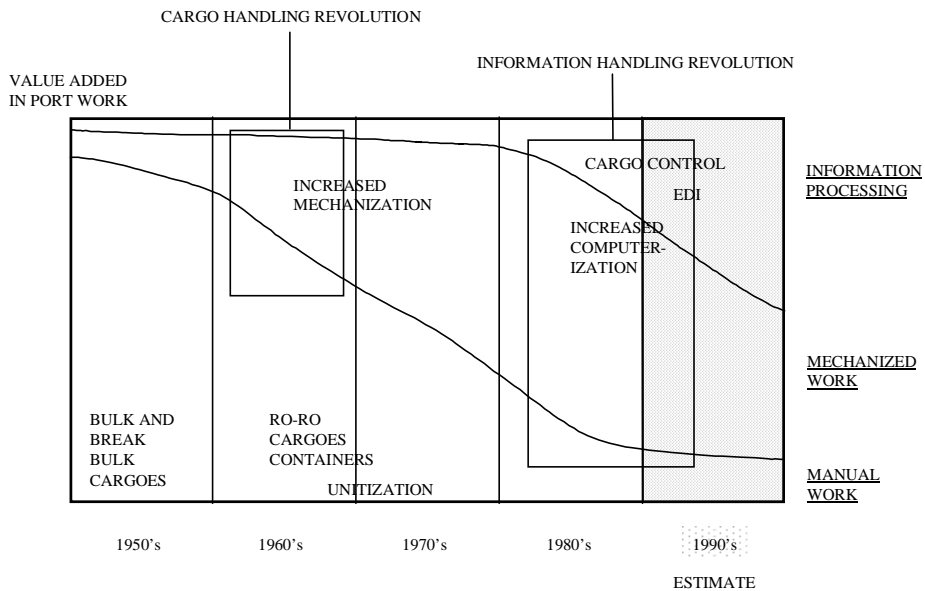
- Lack of wide highways radiating from the port.
- Division of responsibility for handling cargo between the ship's hold and the inland carrier.

Ports however have been subjected to number of innovations during the past two decade. The most important change is the introduction of containerized cargo which has had a major impact on costs, factor proportions and productivity. One of the results of the study of Kim and Sachish points to the non-neutral effect of technological change. The equipment necessary to accommodate containerized cargo resulted in a more capital- less labor-intensive. Additional they show that the rate of growth of total factor productivity in ports has been mainly the result of technical change and, to a lesser extent, economies of scale (Kim and Sachish 1986).

## **6.2 Mechanization and Automation of Port Operations**

The increased mechanization of commerce is a massive multi-industry tendency, not an isolated phenomenon limited to transportation. Development and forward progress of intermodalism is an important and integral part of the overall trend that can significantly impact out way of life (Muller 1989). The need for labor also in port environment has diminished although according to Coyle et al. (1990) 'Labor is required at the terminal to load and unload general commodities. This labor is necessary to move freight from the dock onto the ship and into the appropriate hold for the voyage (and vice versa for unloading). In addition, labor is required to handle the loading and unloading of freight from connecting modes, such as truck and rail, and to store the freight waiting to be loaded onto the ship or connection carriers.' A lot of manual work is already replaced with different kind of machinery and mechanized equipment. This development will continue together with unitized cargo in order to aim to higher productivity.

Three different types of port work have been viewed (Figure 6-1): manual port work, mechanized port work and work related to various information-processing and data-interchange operation (Ojala 1991).



**Figure 6-1** Transition in Port Work after the 1950's (Ojala 1991)

Several different types of cargo handling technologies, such as ramp and deck designs, cell-guides, ro-ro etc. are used for quicker handling of cargo and reduction of the labor required. In ship-to-shore container handling most widely is used gantry type crane, which is built in the form of bridge, supported by a trestle at each end and with a horizontal boom projecting over vessels being loaded or unloaded. Less is used a hinged-boom crane, a type of crane which can pivot on its base. These cranes may weight hundreds of tons; have tens of meters long outreaches and lift capacity minimum of 30-40 tons. The disadvantage is that the quay edge must be designed to carry their heavy loads. Also the bigger the ships, the bigger must the cranes are with longer outreaches for handling of all container slots. Shipboard cranes are used mostly at ports without cranes. In the beginning of the container revolution, before adequate facilities at ports, containers were lifted on and off by the ships' cranes (Muller 1989).

The background cargo handling at the port is used for internal movements between the quay and cargo fields or terminals and for servicing the land traffic. Straddle carriers, reach stackers, terminal tractors, rubber tired gantry cranes (RTG) and rail mounted gantry cranes (RMG) are used for these purposes. The land area utilization with many of the equipment is inefficient. Stacking cranes however require minimum space for

movement and normally are able to stack several containers (e.g. five to six) high. Additionally stacking cranes operations are easier to automate. As waterfront land grows more expensive and harder to find, greater throughput will be squeezed out of existing space. More innovative terminal layouts with more compact designs are needed where subterranean roadways, overhead container grid systems and longer rail sidings may appear (Magnier 1988).

An example of automation and reduction of human work force is the ECT Delta/Sea-Land container terminal in Rotterdam. The processes are controlled by human work force from a control building located in the port area. Although human work force is used, in ship-to-shore operations and in background cargo handling most of the operations are automated and guided with an automated computerized system. The Automated Guided Vehicles (AGV) move containers in the terminal from the ship-to-shore cranes to the Automated Stacking Cranes (ASC) which is used for storing and retrieving the containers. In a more traditional sense there is work force only in the land transportation side (Opening Delta/Sea-Land Terminal - Magazine 1992).

The improving information technology will continue to alter the shipping markets. Computers assist shore-side container operations to ensure maximum utilization of resources, prepare vessel cargo plans, reduce restowages, prepare commercial documentation and control container inventories (Muller 1989). A container ship consists of a capacity of, for example, two thousand 40-ft. container slots. The ship must be balanced in weight from stem to stern, side to side, and top to bottom. The containers also must be loaded in off-loading sequence at destinations. Further, hazardous and other special handling requiring containers must be treated separately and loaded only in particular places on the ship. The reservation system must evaluate each booking request in terms of each ship's voyage, the already planned loads, weights, etc. Computers have changed these once manual tasks into a simpler record keeping and decision system (Coyle et al. 1990). A great deal of the new efficiency in cargo handling is due to the development of computerization in information processing. Data communication links have eased the communication with customs and other authorities and decreased the need for handling paper documents thus saving time and money. In future computers will find way into virtually every area of transportation. The earlier not standardized work

phases and working methods based on tasks made by hands either vanish or are heavily standardized and can be provided almost identical every time. This may require unmanned container handling, equipment identification and traffic control, automatic identification of containers and paper less system for tracking, banking, billing and calculating unit costs.

The constraint of labor organizations is easily understood because the development will generally reduce the number of jobs and amount of labor needed to perform the given tasks. Labor has been a critical problem in both Seatrains and container ship operations (Fair and Williams 1975). In further development there may be other institutional problems in dealing with port authorities and unions (Vepsäläinen et al. 1990). Corporations often continue to follow established practices and find it difficult to develop new patterns either because of conservatism within or the fear of possible retaliation from competitors. The comment of Fair and Williams (1975) that the employment of a new system of transport may necessitate changes in the internal operations and may involve investments which conservative management is reluctant to make, is still valid.

In general mechanization in transportation means a change from labor intensive to a more capital requiring production of services. Typically the productivity per employer increases as investment is made; the profitability of the company however may decrease in worst case. Therefore the increase of the productivity should be measured including wider entity of capital investments made in the operation instead of only examining the productivity of physical activities. In fact there is a question of alternative investments either in labor or technology. On the other hand mechanization and automation includes a risk of stiffening structures. The selection of technology should depend on cargo flows for certain critical mass is required to make terminal automation feasible. Therefore a division between small and big ports needs to be done. If the potential market is split into small transport flows reaching relatively small turnover of goods for terminals it is necessary to use techniques that do not require large investments in fixed equipment (Danielsson et al. 1991). The operator(s) have to be familiar with the needs of the clients and prepared to quickly react to the changes in the market, or alternatively to be able to predict the future developments. On top of the existing physical structures also in-built



political and economical risks in a particular area like organizations, rigid agreements or relations to other companies and traditional practices may prohibit the change to a new way of organizing the business.

### **6.3 Capacity Balancing of Port Operations**

Port operations are mainly conducted by private enterprises with the port administration being a regulating authority (Ojala 1991). Ports are used by multiple organizations that take part in the service production or consumption of the services. The possibility of especially a multipurpose port to implement logistics management in a full measure is limited. One coordination problem is caused by the fact that the organizations are producing partly parallel services and are in competition with each other. Basically a lot of the problems are due to the ships which arrive irregularly in port, whose size and cargo amount fluctuates and which require different kinds and types of services. Cargo handling capacity however is relatively rigid. The congestion in port is noticeable especially in high season of the year, but the demands of services typically vary also on different days of the week. In countries located far from the market areas and with unilateral trade structure, the fluctuations are stronger and have thus special significance for the efficiency in transportation.

The fluctuating ship arrivals are a challenge for port services for demand peaks and valleys are created. The capacity to serve ships is typically balanced to respond to the average demand. As a result ships may have to wait to be served, while the costs caused by low service level are transferred to the ship-owner. The system balances itself by postponing servicing of some ships to the following available time slot. Due to temporary lack of capacity the port may lose clients and thus incomes of cargo charges (underage costs). The capacity can also be balanced according to the peak demand, but other times the capacity is under utilized causing high fixed costs per container and low profitability of port investments (overage costs).

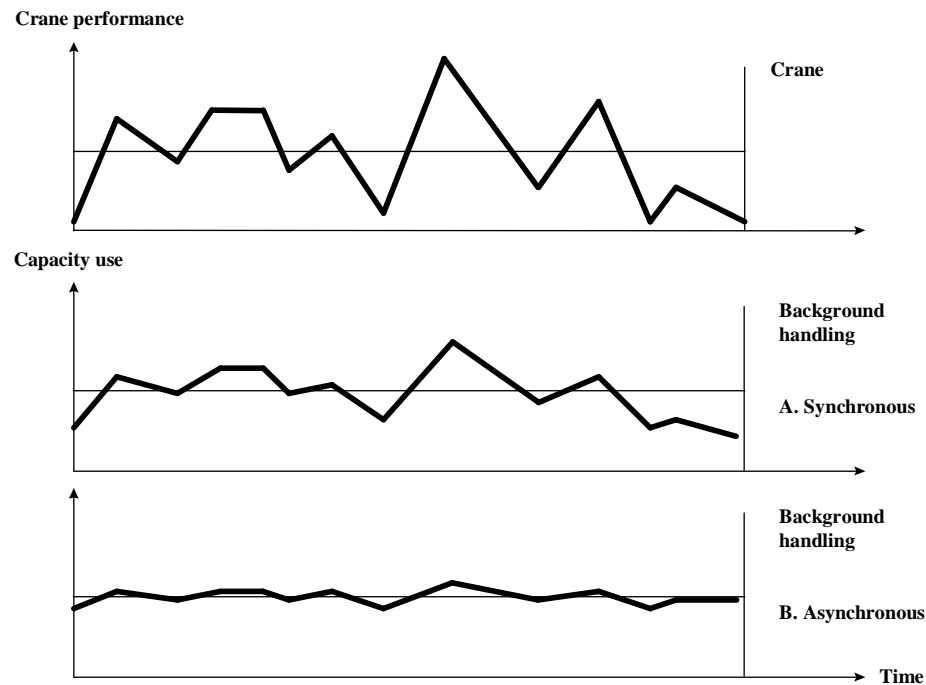
The capacity of port or terminal is difficult to define exactly. 'The capability of marine terminal facilities to accommodate ship calls and the movement of commerce through the port is called throughput capacity. A distinction must be made between a "theoretical"

capacity or the maximum volume that could be physically accommodated in a very short period without regard to a variety of economic and personnel issues and a “practical” or design capacity which represents the volume that can ordinarily be realized under normal operating conditions (U.S. Department of Commerce 1980).’ The capacity of a port is a dependent on equipment (capacity, number and condition), terminal buildings, areas, quay length and the availability of personnel, their work culture and organizing of the work within the rules and laws. The capacity may reduce suddenly because of break down and different kinds of disturbances or external causes like unfavorable weather or strikes. On the other hand the capacity may temporary increase e.g. if is worked overtime. Because of these aspects it is said that the capacity of a terminal is related to speed, cost and flexibility of the service (U.S. etc. 1980).

Internal capacity balancing problems of port operations are also common resulting in reduced productivity (low volumes handled compared to resources available). One of the first steps to increase the throughput of a terminal is to standardize the operations related to cargo handling and thus increase the predictability of the capabilities and reduce the internal uncertainty. The actual processes in transfer terminals however are seldom straight-forward rules, but more often outcomes of the existing “ad hoc” situation, depending on the availability of stevedores, cranes, quays etc. at any one moment (Kondratowicz and Ojala 1991). The system of port operations is complicated. As a remarkable node in the traffic flow, port combines with a series of operations the sea transportation (ship operations) and land transportation (truck traffic and railway operations). Transportation chain has one major difference compared to designing of a production line – typical cargo traffic pass through the transportation chain in two directions as in production or assembly plant there is normally one-way material flows. This should be considered when applying production balancing rules into transportation chain in ports and terminals.

Many industries aspire to JIT production - assuming the demand is predictable and uniform. In such an environment the production is possible to balance optimally. A system where transactions follow each other without delays is called synchronous. However a disturbance, breakdown or unexpected demand peak in any part of the process cause a responding peak in the following process. Continuous disturbances

would make the whole chain to oscillate accordingly. In an operational environment the oscillation is typically dampened for as the latter can't react flexibly, a temporary bottleneck is created causing waiting in the preceding process – throughput of the system is reduced. This applies also in the traditional ship-to-shore - background cargo handling interaction in ports as illustrated in Figure 6-2 (alternative A.).



**Figure 6-2** Demand Fluctuations in the Interaction of Crane and Background Cargo Handling – Alternatives in Practice in Ship Unloading

The throughput of cranes vary between lift cycles due to several reasons – variable lift distances, different performance of crane drivers, mechanical disturbances in devices etc. The performance of secondary cargo handling varies also for container stores and lifting areas for modal changes are normally located on the background areas and containers are moved between the quay and these areas (see also Figure 6-4). The service chain should be constructed so that the resource whose low utilization causes the biggest disadvantage to the process is the bottleneck. All the time “cheap” resources should be available enough to allow the use of “expensive” resource. The minimization of the

(expensive) ship's time in port should guide the organizing of port operations - in the cargo handling process crane should be fully utilized bottleneck. The number of background handling equipment should be measured to serve the crane or it must be otherwise organized to ensure continuous crane operation. If coordinated information cannot be transferred, the parties involved may end up taking preventive actions in order to ensure smooth operation. Therefore the amplitude due to (excess) capacity is even increased. In ship unloading this would mean overage of secondary cargo handling capacity. The basic reason for the phenomenon - delay in information flow in each echelon of the supply chain - is known in system dynamics modeling presented by Forrester (1958). This may create a *Bullwhip effect* discussed by Lee et al. (1997). The latter explained that the parties involved in supply chains from manufacturing to sales have their own, often incomplete, understanding of what real demand is. Each group has control over only a part of the supply chain, but each group can influence the entire chain by ordering too much or too little. Further, each group is influenced by decisions that others are making.

In theory synchronized operations are more efficient, while the work-in-process is reduced to minimum. In port however the demand of services fluctuates continuously. In the port operations with sharp, even only one container lift cycle long demand peaks, the actual operative demand cannot be communicated further in the transaction chain. Therefore it proves to be more efficient to implement an asynchronous system. This separates operations to act within their own restrictions as efficiently as possible by adapting the fluctuations with buffer stocks in between (Figure 6-2, alternative B).

One strategy to develop the port management is to cut off needless activities. Shorter set-up times cut the overall passing time, and also help to achieve quicker response in variable situations. Many changes require a common process design to make them useful for multiple parties. However too far taken standardization and streamlining results in some of the creativity, flexibility and ability to react in changing customer needs is lost in the organization. It is also that the bigger the goods flow, the smaller the relative fluctuations. This can be used in cutting down uncertainty of the service need. On the other hand to extract the highest efficiency is to keep the amounts of cargo within the capacity of the system instead of trying to gather larger volume of cargoes and excess

capacity. The vessel size, number and type of containers loaded should be tied together with the other facilities for a given trade. Therefore shifting container vessel from other trade even on a temporary basis might be difficult (Oda 1991). Distributed investments into increased flexibility and portability instead of solid structures allow quicker response time to fluctuations in local and global level. Investment in e.g. on-board cargo handling offers more autonomous and less capital intensive way for increased total return rate in transportation.

## **6.4 Organizational Solution Case Study - Helsinki West Harbour**

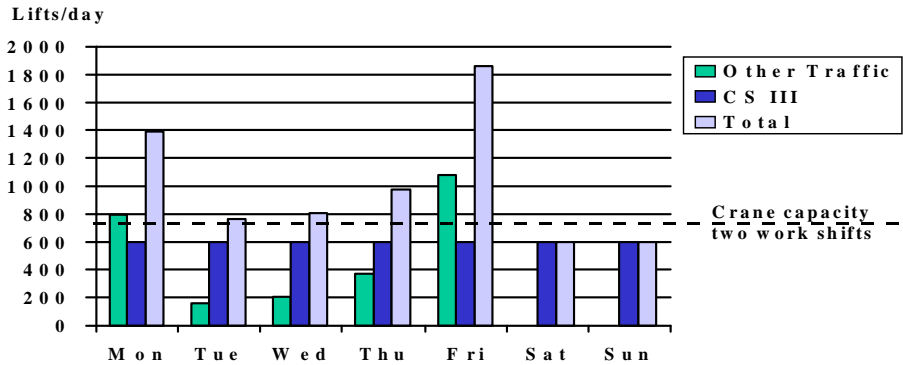
One purpose of the thesis is to discuss of means to narrow the gap between the “theoretical” and “practical” capacity in port operations. Here is presented in brief an investigation made in spring 1994 in the Helsinki West Harbour in Finland concerning the efficiency of ship-to-shore container handling in port. The simulations and findings are described, and the results analyzed in more detail in Laine (1998). The basic challenge was compatibility of capacities between the phases in the ship cargo - secondary cargo handling. It was recognized however that the co-operation between the Finnish (shipping, stevedoring and transportation) company Containerships Ltd. Oy and The Port of Helsinki organization was defined by also other compatibility challenges. The compatibility of interest and targets of organizations and individuals was an issue. Similarly compatibility of service concepts, technological compatibility, geographical compatibility, compatibility in timing, organizational compatibility, in some respect compatibility of skills, and also the cultural compatibility were influencing the process. It was examined the possibilities to intensify the utilization of the port investments (increase the “practical” capacity) with simple rules in organizing the work and changing the physical settings. On the other hand the operational benefits of a widespan –type ship-to-shore gantry crane were analyzed as an alternative to increase the cargo handling efficiency.

### **6.4.1 Traffic and Capacity**

The vessel traffic in the Helsinki West Harbour is mostly so called feeder liner traffic. In the end of 1993, based on the first 10 months traffic, 68% of the traffic was lo-lo handled

in the Saukko Quay (Saukonlaituri), 21% was lo-lo handled in the Melkki Quay and the rest 11% was ro-ro traffic in Melkki Quay (Melkinlaituri). There were 28 ships regularly calling West Harbour under 12 ship-operators. Out of the ships 18 were lo-lo ships whose cargo carrying capacity ranged between 228 and 774 TEUs. The cargo change at port could vary from 35 lifts to 655 lifts per call. All ships except CS III called the port either in 7 or 14 days frequency. (Esko Poltto Oy 1993)

The investigation of capacity balancing challenges was made at the Saukko Quay (Figure 6-3). The irregular arrival of Containerships vessel (CS III) – eight days cycle – caused the capacity demand variation accordingly. During the investigation in spring 1994 another ship for Containerships (CS IV) had started service in seven days cycle. This created an increase in traffic volumes compared to the previous year.



**Figure 6-3** Crane Capacity and Demand of Services at the Saukko Quay in the West Harbour of Helsinki (Esko Poltto Oy 1993, modified)

One possibility to outline the efficiency in container terminal services is to calculate the throughput of containers in time unit per area for benchmarking. The figures in Table 6-1 indicate that in year 1993 almost nine times more containers per area were handled in the Bell Lines terminal in Rozenburg, Netherlands than in the Helsinki West Harbour container terminal. In Helsinki the need for storing containers was higher due to the location in the edge of the European market area, which may lead to longer dwell times for the containers. More important reason however was the differences in the efficiencies in cargo handling and utilization of the capacity. Denser stacking of containers was

achieved in the Bell Lines terminal for widespan type container gantry cranes able store the containers between the legs even in four high stacks with minimum space required between was used. Another explanation is the higher average crane throughput that means short port times for the ships and allowing high quantity of ships to be served in time period in a short length of quay. The efficient widespan cranes of Bell Lines terminal also serviced trucks and trains resulting in low number of background equipment in the secondary cargo handling.

**Table 6-1** Comparison of Utilization of Resources between Two Different Types of Terminals (Port of Helsinki 1994; interview Boe 1994)

	Helsinki West Harbour	Bell Lines Rozenburg
Area (hectare)	32	4.6
Containers handled/year	205 000 TEU	260 000 TEU
Throughput/hectare/year	6 400 TEU	56 500 TEU
Number of cranes	4 (+1)	3
Number of background equipment	>20	max. 5

The efficiency of port operations can be evaluated also by comparing the maximum throughput with the practical performance achieved. In the following calculation of the Helsinki West Harbour crane capacity it was supposed that four ship-to-shore container cranes (one multipurpose crane excluded) could be in 24 hours service seven days a week. In earlier reports made the capacity of each crane is calculated to be 120 lifts per an eight hours shift (e.g. Esko Poltto Oy 1993). This gives an approximate rate of 15 lifts per hour including different kinds of breaks in operation e.g. change of crane driver shift and maintenance. Actually the technical (theoretical) capacity of the port cranes is remarkably higher (at least 33-34 lifts/hour). Therefore the theoretical capacity of the cranes is much higher than in the following moderate calculation for practical capacity of the cranes in a weekly level:  $4 * 15 \text{ lifts/hour} * 0.95 * 24 \text{ hours} * 7 = 9576 \text{ lifts/week}$  (the multiplier 0.95 includes time for e.g. change from loading to unloading or vice versa and maintenance). The annual capacity would therefore be approximately 497 000 lifts compared to the actual figures of about 141 000 lifts in 1993 - calculated from the actual

amount of 205 000 TEU's divided by TEU/unit number-relation 1.45 in the Helsinki West Harbour statistics (Esko Poltto Oy 1993). Capacity utilization was thus approximately 28%. The change in loading rate caused by the irregular arrival of ships (see Figure 6-3) is one explanation behind the low utilization for in order the provide service in peak hours the handling capacity should be balanced accordingly. Second the restrictions of labor utilization cause that the effective working time per day remained low. Therefore much of the crane capacity is not used and the productivity of the investments made in port is low.

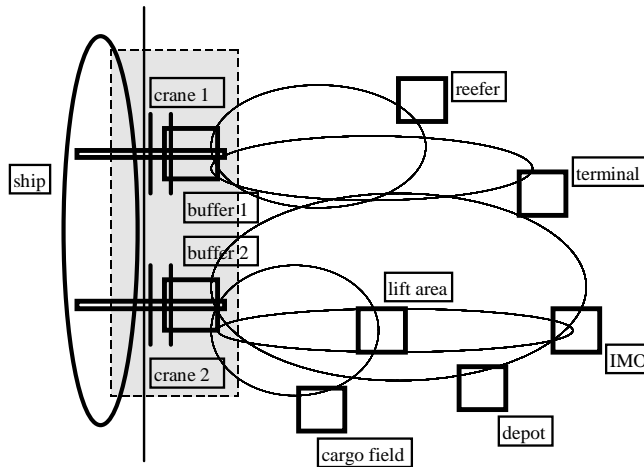
According to the above calculations there was potential to intensify the service production in the Helsinki West Harbour. It was also believed that besides the above reasoning for the low performance, organizing the work also had role. In the investigation solutions were examined for how to increase the lifting rate closer to the theoretical maximum. The traditional operation in the Helsinki West Harbour was almost synchronous. The basic set-up aims to make the cranes and the background handling vehicles operate together in time without delays, although there was a small buffer store on the crane back reach. A disturbance in one sub-process would disturb also the other process. As a result both the capacity of the crane and the background container handling vehicles decreased. It was soon realized that the work could be reorganized by eliminating influence between cranes and background equipment. In practice this would mean a more asynchronized operation where the process is separated to two sub-processes: the ship loading/unloading and background handling, while disturbances or changes in the demand in one of the processes have little or no influence to the other process. Simultaneously the bottleneck needed to be controlled. In the investigation it was observed that the bottleneck moves depending on the point of time and the stage of cargo handling. In the ship unloading the terminal vehicles were the bottleneck for they were not able to clear the crane back reach quickly enough. In loading stage the cranes were the bottleneck because of the reduced efficiency of cargo handling due to the need to position containers into the cargo holds.

#### **6.4.2 Modeling and Simulations of the Case**

The system to be investigated can be defined in several ways; verbally, with figures and symbols, with mathematics models etc. In Figure 6-4 is illustrated the general system of



container movements in ship service investigated in spring 1994 in the Helsinki West Harbour. The movements took place between ship and quay, and quay and several destinations within the terminal.



**Figure 6-4** Investigated System of Container Movements in the Helsinki West Harbour, in spring 1994

The case problem was first formulated in terms of simple mathematic equations. This included resources of the stevedoring company (cranes, secondary cargo handling equipment, storage areas) with parameters, namely capacities, speeds in different directions and distances of moves. In practice however also the time required for hoisting and lowering the cargo and the time spent in releasing/picking-up a container should be included. It was expected that additionally different kinds of disturbances were to be detected in the investigation. Therefore in order to include variable elements in a dynamic environment it was decided to use simulation method in the investigation. Simulation means the description of a real system with some other, normally symbolic system. In simulation the model doesn't search any solution for a problem, but only calculates the result or consequences based on input assumptions. This means that very complicated mathematical dependencies can be applied to describe complicated systems (Hautaniemi 1995). The advantage of simulation method over some other methods is its ability to easily include stochastic into the models (Seppälä 1997).

The data for investigation was collected in a monitoring made in the Helsinki West Harbour in two periods in March 1994 for Containerships III vessel. The ship was handled in the Saukko Quay with two cranes – the Port of Helsinki cranes number two and three. The weather conditions were good during both of the monitoring periods and the crane drivers performed well (the ship loading and unloading was completed efficiently compared to the previous average performances). In stevedoring Containerships Ltd. Oy used three straddle carriers and two terminal tractors for servicing the cranes. In the monitoring the exact moment in time for every single action or operation was measured. From this data the cycle times - the inverses of the outputs of the cranes and background vehicles - were calculated. It was recognized that the sub-processes disturbed each other. The moment of disturbances was measured, their duration was calculated and the reason for disturbance was recorded. Due to the differences in the operation principle and efficiency this was done separately to loading and unloading stages. In the crane - background handling equipment interaction the calculated cycle times were analyzed and factors influencing to them were defined. Especially the crane cycle times were divided into smaller pieces for analysis. This offered data for search of solutions to increase the efficiency of cargo handling.

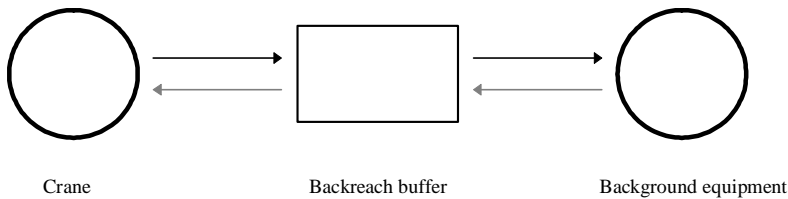
According to Hautaniemi (1995) discrete simulation is used in systems that change step by step (port operations, assembly industry and queuing processes). This approach was found applicable also in this case. The simulations were made using ProModel PC-program - a discrete event simulator. Every container lift and resource was simulated. The simulator had been used in similar work previously. These models were modified based on the data collected in this case. The simulation model and the simulation runs were made by a simulation expert. The models were rebuilt so that two disturbance distributions were set to influence to the crane operation. With these distributions the maximal technical efficiency of the crane was reduced to correspond with the actual efficiency observed. The first of these distributions included the systematic and fortuitous disturbances caused by the crane itself. The other distribution included the disturbances the background vehicles caused to the crane operation.

In creation of a simulation model there is according to Miser and Quade (1988) several phases. The problem is first analyzed in order to build a conceptual model of it. On the

basis of that a mathematical model is built. The verification process means verifying that the mathematical model actually represents the conceptual model. Finally, various experiments and validation actions are carried out with this mathematical model in order to validate it. The verification of the model can be done by validation; that is, if the output of the implemented model seems to represent possible outcomes of the conceptual model, then it may be assumed that the simulation model is correct as well. So was the simulation models used here verified and validated. The simulation models made it possible to describe a wider entity systematically and outline the mutual interactions between operations. The simulations were used in the crane operation - background cargo handling interaction. The rest of the port operation (background cargo handling) was described in the simulation with distributions. First a basic situation corresponding to the actual measured crane operation was created, and the simulation model was tested for the validity in this situation. The simulation results in the basic situation corresponded well with real data - the difference between simulation results and reality was only 4 minutes and the model was giving reliable results in the total handling time. Next the alternative solutions to organize ship loading and unloading were simulated in order to define the lifting rates and total cargo handling times for the ship. With simulations it was relatively easy and quick to go through several alternatives and the stochastic view could be included into the analysis. The target was that the disturbance percentages in the simulations generated by the two distributions respond as accurately as possible each disturbance occasion. It wasn't possible to balance the disturbances fully in every simulation - in the worst case the error was around five percent of the total time. Some assumptions had to be made for there was limited practical evidence of some operational details. It was estimated e.g. the increase in time when stacking containers instead of lifting them to the ground.

In all the simulations of alternative solutions the two processes were separated from each other with buffer store on the crane back reach. The influence of different size of buffers together with supporting arrangements was simulated for these were not possible to test in real life. The principle of the system is described in Figure 6-5. The target was to eliminate part of the delays with asynchronous operation and increase control over the bottleneck (the crane). The idea was to test if with enlarged buffer store the crane could lift containers from ship (or vice versa) with its maximum efficiency without caring the

background handling. In practice this would have meant allowing more containers to be lifted to the crane's back reach and between the legs. Correspondingly the background equipment should be allowed to operate separately as long as there would be store capacity and cargo enough. Background equipment supposed to be controlled not to meet the crane trolley on the back reach. Also the buffer system should stay within the capacity defined - lifts to the buffer and lifts out from the buffer should remain to conclude an amount of containers that can be hold within the buffer capacity. Otherwise either crane or background equipment has to stop making moves to the buffer to balance the system to meet the limitations.



**Figure 6-5** Cargo Transfer between Crane and Background Equipment

Another alternative is to empty the crane back reach with straddle carriers to temporary stores at the quay area from where the containers are further transferred to container fields. It allows minimizing the disturbances caused to cranes for due to the short distance the duration of straddle carrier move is uniform, gives more moves per time unit and offers more flexibility to choose the exact time to pick up container. This operation however would have required storing more than one hundred containers for a short period of time. In a congested port this is not possible in a bigger scale unless the container fields located close enough the cranes can be used.

### 6.4.3 The Investigation and Simulation Results

The technical lifting rate of the Helsinki West Harbour cranes were not achieved in practice due to the lay times caused by different organizational and technical disturbances, and elements related to crane and straddle carrier drivers. The latter included for example variations in performance and skills of the drivers and the regulated working times and shift changes. Operational and technical aspects included

opening/closing of hatch covers, shifting the crane between cargo holds, difficulties in positioning containers in the cargo hold, removing the container clamping devices (twist-locks) from deck cargo, handling of 30-foot containers, slow handling of twisted containers, and technical problems in the spreader. These disturbances had also indirect influence to the background cargo handling. In addition there were disturbances directly related to the crane – background handling interaction: The buffer getting filled in unloading, the waiting for certain container in loading and the disturbances caused to the crane by terminal vehicles on the crane back reach. In the latter situation crane had to wait for straddle carrier on the back reach prevented crane trolley movement.

In unloading lay times and disturbances increased the average lift cycle time of the crane number two by 28 seconds and the rate dropped down from 28.3 lifts/hour (without disturbances) to 23.3 lifts/hour. The disturbances caused by background handling alone contributed 1.3 lifts/hour decrease. Similarly the efficiency for the crane number three decreased from 32.4 lifts/hour to 28.4 lifts/hour. The loading of ship was slower than unloading for the containers had to be positioned in the ship cargo hold. Also there was difference between loading cargo to the hold or on the deck. For the crane number two actual rate for loading cargo hold and deck were respectively around 24.5 and 18.5 lifts/hour. In addition in every one and a half or two hours around 15 minutes was needed for closing deck hatches. The average lifting rate in loading (with disturbances) was around 19.5-20 lifts/hour. The rate measured for the crane number three was around 21 lifts/hour. The “normal” performance represented by the average of medians would have been 22.8 lifts/hour and 26.1 lifts/hour for the cranes two and three. The disturbed performance was represented by average of average values and gave 19.3 lifts/hour and 24.2 lifts/hour respectively for the cranes. In switching from unloading to loading of the ship, the cranes had to wait until background vehicles had cleared the crane back reach for export containers. This because of loading and unloading overlapping was not allowed. During the investigation this waiting time for crane number two was 12 minutes. The more efficient crane three had to wait around 44 minutes although it had already discharged its share of the cargo for it had to wait until the other crane had done its work and the back reach was cleared.

There is an obvious result that if the distances in internal moves are reduced, the availability of background handling equipment increases. This also allows reduction of disturbances for e.g. straddle carrier has more time to wait until the crane trolley is not on the back reach. The size of buffers in the traditional operation was too small to adapt the variations in the crane and background vehicle performance resulting in waiting and drop of efficiencies. In the first simulation the buffer size was expanded to 12 containers which is easy to arrange in practice. The shares of total time when the buffers are full are decreased and the crane more seldom wait slot for the container. Also the disturbances should decrease, while the background vehicles have more possibilities to pick up container without disturbing the crane. On the other hand such operation is slower for containers are stacked and lifted between the crane legs. This was included in the simulations with ten percent increased disturbances during unloading. The total simulated cargo handling time was around 13 minutes shorter.

The buffer became filled more seldom during unloading with buffer size 12 and one additional straddle carrier. In the loading phase there was all the time cargo available for the crane. The cargo handling time was reduced with the reduced waiting time of the crane. There was a difference between the efficiencies of the cranes in the loading phase for the disturbance percentage of the crane three was by accident too low in the simulation. However this didn't have influence to the total cargo handling time. Some time can be saved because of the quicker emptying of the buffer after ship's unloading. This means that the loading phase could begin almost without delay. The time saved compared to the situation without additional straddle carriers was around 60 minutes. The time saved due to unlimited buffer sizes compared to the buffer size of 12 was only about 10 minutes with the original number of background vehicles. However if allowed the buffer be congested before loading phase, the time saved would have increased to over 50 minutes. The number of containers in the buffer increased quickly during the unloading. The buffer size should have been 35 slots in order not to limit the crane operation, but 45 if the buffer wasn't cleared between phases.

The disturbances caused by the background vehicles in the simulation were eliminated with additional stores located in the quay area (at a distance of 100 meters). Straddle carriers could effortlessly clear the crane back reach in unloading phase. As a result the

total cargo handling time was almost two hours shorter compared to the basic situation. It was assumed that the straddle carrier time distribution is a triangle distribution – between the crane and store the average was 1.5 minutes and the variation between 1 and 2 minutes, and between the crane and container field the average was 5 minutes and variation range between 2 and 8 minutes. The store levels grew very quickly while the vehicles reserved for the long transfer had only half of the capacity of the cranes. The straddle carriers - clearing the back reach – were allowed to make a long transfer if there was only one container in the buffer. Size of the stores should be up to 80 containers each and can be quickly cleared after the ship leaves the port.

The long time average rate of a crane (in 1994) was only around 15 lifts/hour. The influence of this was evaluated in a simulation with 40 percent reduced performance of the cranes (13.4 and 16.8 lifts/hour respectively). The rest of the parameters remained. The results showed 3 hours 15 minutes longer total cargo handling time for the ship in the basic situation. The influence of the solutions to the ship's port time based on the simulations and calculations are collected to the Table 6-2.

**Table 6-2** Simulation Results for Alternative Cargo Handling Solutions in the Helsinki West Harbour / Widespan Crane Performance

Alternatives	Stage	Crane 2 (min)	Crane 3 (min)	Duration (min)	Time difference %
<b>Basic situation</b>	Unloading	374	348		
	Loading	464	412		
	total (waiting)	838 (1)	760 (27)	839 (1)	-
<b>Buffer 12</b>	Unloading	353	341		
	Loading	453	412		
	total (waiting)	806 (20)	753 (32)	826 (20)	-1.5
<b>Buffer 12 + straddle</b>	Unloading	336	318		
	Loading	429	352		
	total (waiting)	765 (1)	670 (19)	766 (1)	-8.7
<b>Buffer unlimited</b>	Unloading	309	304		
	Loading	440	442		
	total (waiting)	749 (64)	746 (69)	815 (64)	-2.9
<b>Additional stores</b>	Unloading	308	301		
	Loading	423	406		
	total (waiting)	731 (-5)	707 (1)	723 (-5)	-13.8

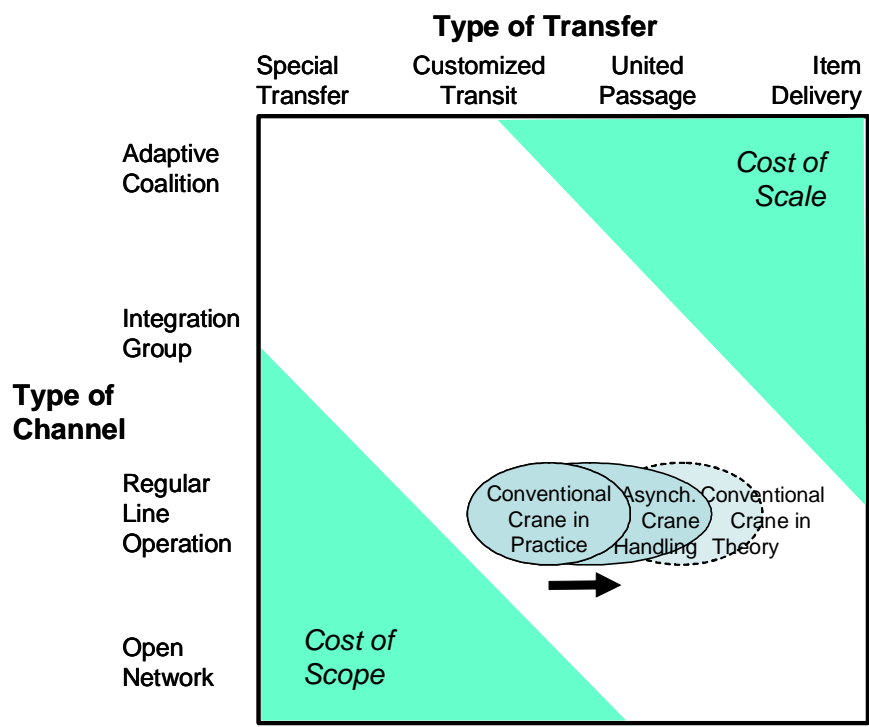
Alternatives	Stage	Widespan	Duration (min)	Time difference %
<b>Widespan crane</b> (direct calculation)	Unloading	612	612	
	Loading	743	743	
	total (waiting)	833 (-522)	833 (-522)	-0
<b>Widespan crane</b> (actual performance)	Unloading&loading			
	Total	900	900	+2.5

The figures in the above table show the approximate cargo handling times for each alternative. The number in brackets is the waiting time in transfer from unloading to loading of ship. Negative number means that the unloading and loading are overlapping - in other words double-cycle cargo handling is used.

The transfer distances of the background equipment were long in practice and duration of transfers highly variable. The recommended solution based on the investigation was to use short straddle carrier moves from the crane back reach to storage areas located near the cranes. This would have decreased ship's port time due to intensified crane capacity utilization and without needs to increase secondary handling equipment. From the crane handling point of view the situation is close to the theoretical ideal of undisturbed crane work (Figure 6-6). If not possible to arrange in practice (due to lack of space for



example) the other alternative was to increase the size of crane back reach buffer to 12 units – the asynchronous crane handling method shown below.



**Figure 6-6**    Operational Management Innovation – Asynchronous Crane Handling

In the investigation it was noticed that by motivating labor and allowing more flexible working time arrangements the efficiency of cargo handling could be significantly increased. Separating the processes also offers better opportunities to evaluate the performance of the labor, expose the problems more clearly and create basis for building up incentive systems. Since the investigation some work practices changed at the Port of Helsinki terminal. Earlier background equipment was dedicated to serve certain crane but later they have served several cranes according to the needs. Having the crane first priority so that the background vehicles give way for the crane trolley on the back reach increased the efficiency. Most of the disturbances caused by secondary handling were thus eliminated. The need of cranes to travel when moving containers was reduced and method was searched to quicker remove container clamping devices. Also the

importance of good condition and reliability of the equipment to the efficient operation (time of the ships saved) was recognized. Since the investigation the role of maintenance and repair has been emphasized especially in the crane work. The biggest change however was the introduction of Widespan crane in the Containerships operation in summer 1995 that was partly motivated by the results of the investigation.

## **6.5 Technology Solution Case Study - Widespan Ship-to-Shore Gantry Crane**

Widespan ship-to-shore container gantry crane concept was included in the above investigation as an alternative to completely change the cargo handling method. A calculation was made based on specification of a widespan crane that was to be purchased by Containerships Ltd. Oy to be handed over in June 1995 to the Saukko Quay in the Helsinki West Harbour. Experiences from other terminals in Europe had indicated that the concept could intensify the port cargo handling, increase utilization of the investment and further integrate the transfer chain. The most important feature of such crane is the sufficient container stacking capacity between its span. Therefore, contrary to traditional ship-to-shore cranes, widespan gantry crane is asynchronous solution. The need to move containers and therefore dependence on background vehicles is nearly eliminated while the ship is berthed. Also most secondary handling can be done by the crane on its back reach. It facilitates flexible change between ship unloading and loading phase and make it easier (than traditionally) to carry containers in both directions (double-cycle). This result in more efficient utilization of land for specific areas for export and import containers is not required.

The total cargo handling time (see Table 6-2) was calculated based on estimated efficiencies of 35 lifts/hour in single cycle and even 55 lifts/hour in double-cycle. These efficiencies were reduced by 10% because of an estimated need for servicing land transportation at the same time. In this calculation the total number of lifts was estimated to be the same 600 as in the simulations. It was also estimated that approximately 43% of the containers were on the deck and the rest in the cargo holds. In an ideal situation there would be around 260 containers in single cycle and 340 in double-cycle. This

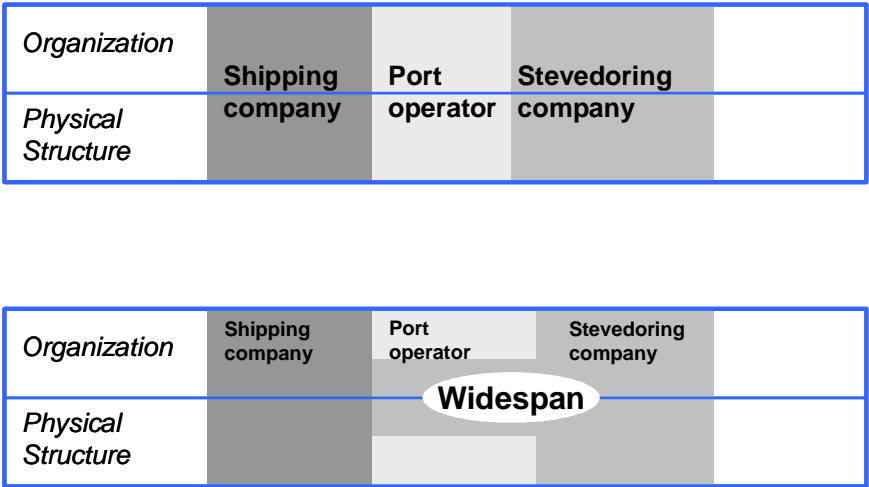
would give a total cargo handling time of 833 minutes, which was almost the same as what could be achieved in the traditional operation with two cranes.

The widespan crane has been in operation a decade. Already the first couple of months showed significant increase in the lift rates compared to the traditional operation. It took however two years the crane drivers and traffic control personnel achieve the top performance. In year 1997 the cargo handling rate for the urgent, scheduled ships had raised to 37 lifts/hour for the ship in average despite of some trucks were serviced at the same time. In the best case it was 40 lifts/hour. Another investment was made later and since 2003 Containerships has operated two widespan cranes at the Saukko Quay.

In order to further intensify use of direct lifts on trailers or trucks during ship work would have in wider scale required re-design and coordination of quay traffic. It also slows down lifting for more precise driving is required from the crane drivers. The main benefit of using double-cycling is the reduced number of lift cycles. Simultaneously however the average duration of a lift cycle is increased. The lift distances together with the gantry travel, trolley travel and hoist speed partly define the additional time required. Positioning of containers in the cargo holds limits the sequences when double-cycling can be used. The land side must be organized to minimize need for traveling and search for export containers, and to support correct order for loading. The crane in question (span 48 m) was able to travel in three directions simultaneously and quickly - gantry speed 120 m/min, trolley 180 m/min, hoist 40 m/min (full load) and 100 m/min (empty). The setting was favorable but Containerships has not applied double-cycling yet due to unlikely time saving. The main reason is that certain work rhythm is easier achieved by the drivers in single cycle. More intensive work and other related psychological aspects also require high motivation from drivers. However with experienced and motivated team, organized land side, involved ship personnel (twist locks handling unless cell-guided ship) etc. and with a tool assisting or even automating operative decision making, the benefits could be realized. Time saving is easier achieved with bigger or hatchless ships.

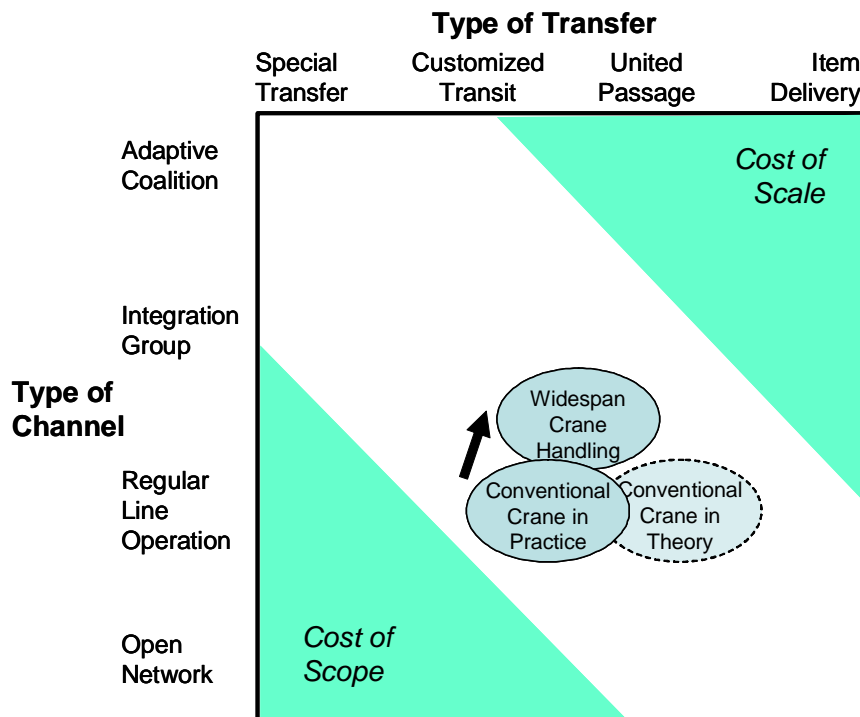
Widespan crane operation has reduced terminal space requirements due to higher stacking and minimum space needed between containers (compared to straddle carrier operation). Also the loading and unloading take turns and thus the same space can be

partly used twice for stacking. The crane is also used for stevedoring work which breaks the traditional division into ship-to-shore operation and stevedoring. It is benefited from that the widespan crane is an integrative technology investment. It combines the operations, reduces interfaces between organizations and buffers capacities over the transfer point (Figure 6-7).



**Figure 6-7** Crossing the Interfaces - the Case of Widespan Crane Technology

In an environment of stable cargo flow (the ideal system) conventional type of ship-to-shore crane is positioned (Figure 6-8) in the diagonal of the Transfer Service Matrix. However in practice the crane operations meet fluctuating demand with long idle times of no ships to be serviced. Even during a single ship call the work load varies – the secondary cargo handling system is usually not able to create uniform cargo flow for the crane. Widespan crane is better positioned to respond to variable service needs, and also creates a more integrated entity with reduced compatibility issues. Fluctuations are balanced with buffering in the storage area and crane is able to work undisturbed. It also serves truck traffic when not servicing ships. This result in higher lifts/hour rates for the ships as well as reduced need for secondary cargo handling capacity.



**Figure 6-8** Influence of the Widespan Crane Technology

The need for solutions like widespan cranes (with buffering capacity between sea and land leg) may be indication of non-continuous cargo flows and problems in the balancing of the transfer chain. It is possible that in the future transfer networks this kind of solutions become required especially in feeder traffic in smaller ports with few calls, unless self-loading ships begin to conquer the market.

## **7 Research Results and Discussion**

The contribution of the thesis in terms of theoretical results are presented in this chapter. The implications of the research for transfer chains and container shipping are also briefly discussed here.

### **7.1 Summary of the Theoretical Results**

The construction of the theoretical framework for the analysis of transfer services is the most important contribution of the thesis. In this framework called the Transfer Service Matrix (TSM), physical goods transportation and related cargo handling services (transfer service) can be positioned and analyzed. Transfer service is a service solution where certain type of transfer need is satisfied with supply through a certain type of transfer channel. A wide range of special factors are influencing to the form and development of the transfer services offered and therefore to the whole logistics and transport sector. As recognized in the literature review transfer services are seldom analyzed separately the focus being in the general classification of services. A framework intelligible and simple enough for a conceptual level investigation, yet not too simplified to facilitate transfer service analysis was needed. The justification for the TSM is based on the observation that different kinds of transfers should be performed with a type of transfer channel that meets the customer's transfer needs. The target to create something similar to what Hayes and Wheelwright (1979) did for goods production in so called Product-Process -matrix was achieved.

The purpose of the TSM is to classify different transfer types and different transfer channel types in order to position current transfer practices, visualize, analyze, and thus help to outline the future development of goods transfer solutions. In this work first the essential elements of physical transfer were defined. Next the different transfer types (needs) were classified as special transfer, customized transit, united passage and item delivery. Similarly the transfer channels on the supply side were classified as adaptive coalition, integration group, regular line operation and open network. Finally the TSM was constructed by matching the four types of transfer needs and the four types of transfer channels in a matrix. The generic transfer service solutions were also presented

in the TSM as benchmarks of the four assumed efficient combinations of transfer needs and transfer channels.

The second contribution of the thesis is discussion and outlining the scenarios for container shipping chains and visualizing them in the TSM. The TSM is used throughout the thesis in the analysis and illustration of the potential container transfer service considering several issues (e.g. ownerships, service scope and future service composition, and influence of innovations). The future scenarios are based on the change drivers presented in the literature namely, the assumed changes in cost structures and service preferences of customers to give an example.

The purpose of this research was to investigate the entity of cargo handling and transportation. Cargo handling as a mean to combine the different phases of physical goods transfer is stressed in the dissertation whereas transportation received less emphasis. The opportunities of parties within the supply chain (intermodal container transfer chain) to improve the balance of operations by proper alignment of the technological resources and management practices are investigated. In many future scenarios in the ever more global competition and continuously more dynamic demand-supply relationships between organizations, capabilities to establish working portfolios is likely to have a more important role. The scenarios involve networked business models where service phases are interlinked to formulate adaptive networks or service entities of temporary nature. In this context the third contribution of this thesis is the discussion of the various compatibility challenges in between organizations in transfer chains and the respective suggestions - like standardization initiatives - for bridging the compatibility gaps.

A wider concept of transfer service production in the supply chain should be investigated instead of e.g. transportation as a separate issue. The compatibility of capacities between transfer phases in container shipping, the influence of cruising speed of ship vs. cargo handling speed, and the efficiency achieved with alternative technology investments is investigated from the shipping company point of view. An analytical model presented demonstrates the economic tradeoffs between the investments in cargo handling and ship propulsion technologies, and the roundtrip frequency and profit potential for the shipping company. Hence, the fourth contribution of the thesis is the introduction of this model

for defining the most efficient investment strategies. According to the analyses, investment in cargo handling especially in short routes may yield a remarkably higher return than in ship propulsion. Alternatively the ship size could be reduced. In an example where the loading speed is 60 TEU/hour for a 500 TEU ship, 70 departures a year is achieved. This is twice the frequency of a 1000 TEU ship loading at slow 25 TEU/hour rate when both ships are cruising at 22 knots. Additionally a case analysis of an advanced technology concept of a self-unloading ship type, *Twinstar*, is presented. Ideally significant savings in costs may be achieved. In an example calculus for 1000 TEU ship the saving was 117 \$/TEU transported or more than 30 percent compared to conventional ship. However since these results were first published, such potential is weathered for a *Twinstar* -type of solution for the efficiency in port operations is significantly increased in comparable routes. Therefore the actual figures in the calculus's results is not any more that relevant as they used to.

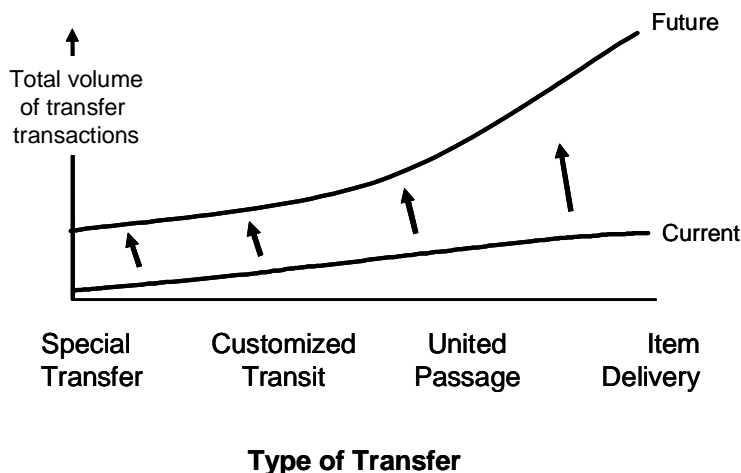
The fifth contribution of the thesis comes from where the ship-to-shore crane and container background handling equipment interference was observed. There was a port operator/ stevedoring company point of view in this investigation. The results, however, are at least partly outdated for several (suggested) developments have taken place in the case port environment since the investigation. On the other hand the principles are still applicable in less advanced ports. The case empirical data was collected and used for input material of simulations where the coordination of ship-to-shore operations and background handling was analyzed. Two case analyses to increase efficiency in port work were presented – one for new arrangement to organize the ship cargo handling work, and one for technological solution of the same. The opportunities of the port operator and stevedoring company in establishing priority rules for the process were studied too. The investigations made in the Port of Helsinki West Harbour and the simulations conducted showed that utilization of the existing facilities can be intensified. Setting of new prioritizing rules for the cargo handling equipment and increasing of the size of buffer stores, the internal process disturbances of the ship cargo handling are significantly reduced. In the best case the increased cargo handling efficiency led to approximately 14 % reduction in the ship port time. The technological solution of the case study gave even more promising results. The actual port terminal development project with the new technological solution and organizational changes increased the



cargo handling efficiency for ships by more than 50%. As a consequence the utilization of the ship capacity can be remarkably intensified. It was central to eliminate friction in between the organizations by reducing the number of organizational interfaces (vertical integration) and by better match with the demand patterns. The technological solution (widespan ship-to-shore container gantry crane) alone eliminated work phases allowing temporary store of containers underneath in the stacking area.

## 7.2 Discussion

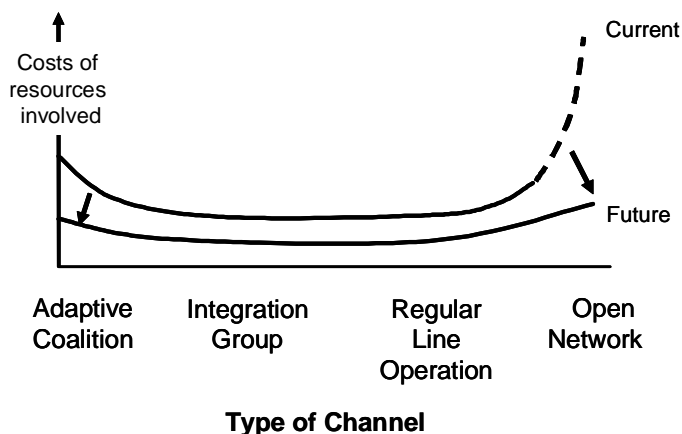
There are several forces influencing the transfer chains. The currently found to be the most important forces of change are discussed in the dissertation. The globalization development translates into increased demand for physical transfer services. The consequences vary in different geographical areas but the international transfer transaction volumes tend to grow. At the same time the deregulation in trade is likely to advance, although like stated by Coyle et al. (1994) whereas there is probably less economic regulation simultaneously the noneconomic regulation is increasing. All in all these two phenomena are contributing to the same direction. Their combined influence in the type of transfer services is illustrated in Figure 7-1.



**Figure 7-1** The Likely Influence of Globalization and Deregulation in the Type of Transfer Services

Presumably there is relatively higher increase in transfer transaction volumes for standardized goods (typically smaller in size) where scale economies also in production are enjoyed. There are indications of this already as according to the global division of work e.g. many components are increasingly sourced in certain geographical areas. Besides the resulting reduced transaction costs, important issues are raised by the rate and bias of technical change. It is shown that the growth of total factor productivity e.g. in ports has been mainly the result of technical change and, to a lesser extent, economies of scale. The rapidly developing technology is believed to be one of the most important factors influencing the transfer cost structures also in the future. The applications in information and communication technology are more likely to be the sources of potential revolutions whereas in the transportation equipment and physical cargo handling the development will probably be more gradual.

Technological invention typically originates in smaller companies with special customer needs. The influence however is probably intensified if the innovation is adapted in larger networks. The technological development is closely interlinked to the physical prerequisites - the physical structures consist of infrastructure and the superstructure built on top of that. The organizational and technological structures formulate the capabilities and channels in the transfer service supply. In this field the related forces of change are expected to have the combined influence illustrated in Figure 7-2.



**Figure 7-2** The Likely Influence of Adapted Organizational and Technological Innovation in Transfer Services

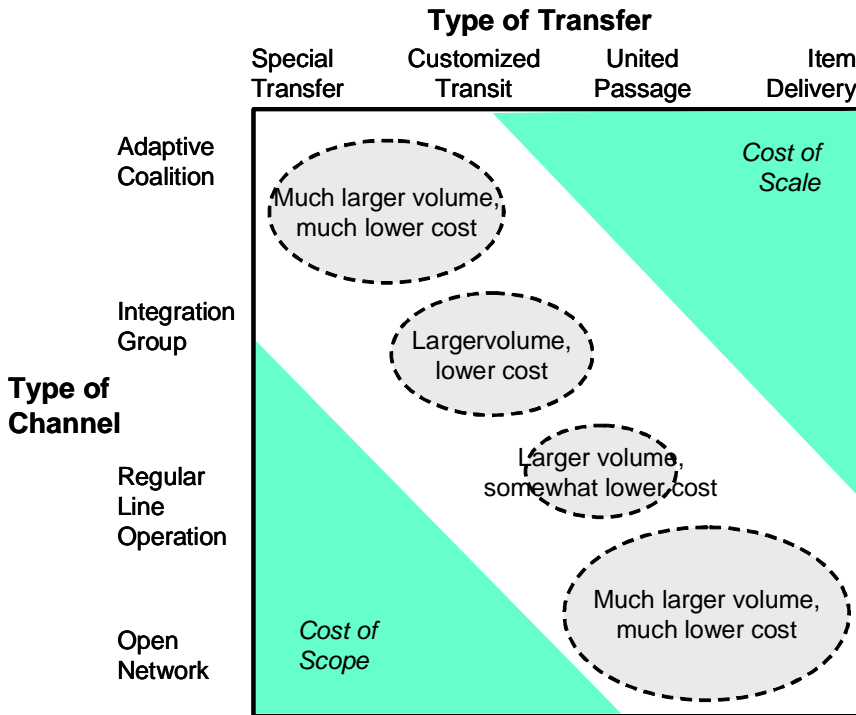
The organizational issues and innovations easily get less emphasis despite of the role in defining e.g. the resources involved, risk sharing, and therefore the costs involved. Depending on the case either one organization but more likely several organizations together form the transfer channels. The transfer service portfolios are formulated of services offered by different companies or organizations in the channels that either directly produce activities in physical transfer of cargoes or are in the supporting role of the same. Organization wise in ideal situation the channels further right in the Figure are likely to allow more efficient resource utilization. As a conclusion the technological and organizational innovations combined offer more potential in the channels in the right end of the axis resulting in reduced costs.

The costs structure of different transport and cargo handling systems (including infrastructure) diverge. The higher volume of resources (physical, human) is involved – downwards along the vertical axis – the more the total costs tend to grow. At the same time the higher level of industrialization transforms variable costs to fixed costs. More importantly the total costs per transfer task tend to be reduced. In order to fully enjoy this matching of service supply with customer needs is necessary. In addition efficient utilization of investments and other assets in terms of balancing of capacity is required. In rail transport for example, once the investments are made - resulting in high fixed costs - the variable operative costs within the (closed) network are relatively low. The success is dependent on transaction volumes as only with increased volumes the absolute fixed cost per transaction would be reduced. A typical solution is where a rigid system is fed by more flexible surrounding network – the main leg in the service portfolio is carried out cost efficiently whereas the sub-subsequent legs and further deliveries are covered with more flexible services. In that sense for example intermodal or bi-modal (truck-train) transport has proved successful in some geographical areas.

In trade, and in industries servicing consumers, self-service is introduced to cover the transfer service phases and operations closest to customer. This applies also to business-to-business where manufacturers have e.g. their own consignment operations. In these phases the service demand is difficult to predict and individual task hard to trigger due to lack of information. Such transfer tasks actually have similar features as project deliveries. Therefore the “first mile” e.g. in mail service – collection of mail – is left to

the customer whereas the “last mile” delivery (the information is more complete for resource allocation) is transfer service to the customer premises. The resources and manual work (passenger cars; roads and parking facilities; store; store internal transfer; picking, pay desk and packing work, etc.) in the self-service for example in grocery supply of families are remarkable. Home delivery service introduced could reduce the amount of work and resources. This would require the thin individual goods flows to be efficiently and flexibly combined into bigger volumes. Thus some phases (and facilities) in the current transfer network could disappear and partly be replaced with new operations. Several experiments - and currently working solutions (e.g. by companies like Amazon or Tesco) have modified transfer networks from the supplier to end customer. However a lot of traditions and psychological issues related to human behavior overwhelms rational cost-based reasoning and may prevent the implementation of such services in a larger scale. In terms of cost reduction the combined influence of forces of change is likely to be strongest when relatively small and easily transferred items are handled by networks that flexibly allocate resources to match demand over the organizational boundaries. Truly global service offering to end customers using internal organization or closed networks would lead (unless global monopoly) to explosion of the costs involved for resources remain significant time idle.

The outlined cost curves of likely scenarios on the Transfer Service Matrix (efficient) diagonal in relative seem to play to the favor of networked solutions. This would create a field - in the down-right corner of the TSM - where the likeliest developments would take place as illustrated in Figure 7-3. In the up-left corner again the technological inventions are likely to boost the development. In between these two ultimate ends the development is probably gradual instead of revolutionary. The capabilities in the Integration Group probably benefit more of the standardization and organizational developments whereas stream-lining in the Regular Line Operation mainly of technological development steps and operational management practices.



**Figure 7-3** The Field of the Most Significant Changes in Transfer Services

This deduction would support also the compatibility issues discussed considering e.g. container shipping. The creation of open and flexible organizations allows efficient use of resources even in fluctuating demand conditions. If however against predictions regulation is intensified again, globalization development is hindered, traffic flows are concentrated and no significant technological or organizational innovation take place, rigid integrated chains may well stand up for the position also in the continuation. Currently in the high demand conditions they also seem to generate wealth to the service providers.

## **8 Conclusions and Future Research**

The conclusion of the thesis together with practical applications and managerial implications is summarized in this chapter. The further development of the Transfer Service Matrix as well as other future research topics is also discussed here.

### **8.1 Managerial Implications**

The prerequisites and actions of the parties of the transfer chain or network in building capabilities are investigated in the thesis. The actions result of management practices and decision making (besides technological advancements and changes in surrounding economy). These include efficient manipulation of the physical cargo flows by proper alignment of the technological resources and organizational forms. Matching the supply with demand in different respects is one key to efficiency. This is complemented with more operational issues in service production arrangements and coordination of the physical cargo flows.

The central managerial implication of the thesis is to stress that the biggest development potential lies in a holistic development of transfer chains. Special emphasis is given to efficient interfacing where cargo handling links the transfer phases or organizations (although operational efficiency of individual transport phases is also elementary). The functioning entities define how successful the service is in the eyes of the customer. In a long run this tends to be translated in the biggest cumulative benefits and financial success to the service provider(s). Ideally a variety of services develop simultaneously as in most cases individual services are part of a service portfolio. Development could start from the transfer needs driven by trade activity. Also other way round supply of efficient services may create new business opportunities and also result in accelerated trade due to diminishing trade barriers. The Transfer Service Matrix developed in this dissertation would help service providers to position their service offering and transform it according to the foreseeable customer requirements.

In analyzing various practical challenges, and current and potential future business concepts, theoretical conceptual frameworks are of great help. This however is hardly

enough. On the contrary besides the holistic development initiatives and comprehensive scenarios a lot of the development is driven by innovations. The appearances of innovations are also difficult to predict. In order to achieve real progress in transfer services chains and in supply chain/network management the scenarios illustrated must be realized with inventions, their practical implementations, and diffusion of innovations in the industry. In this sense container shipping is investigated in the thesis. This includes an industry scan and somewhat a technology scan. In addition the future is outlined in the thesis with organizational structures and channel speculation. The majority of development initiatives and supply chain management projects are not systematically supported by governments or other public organizations but are driven by entrepreneurs and private companies. Innovations in operational processes may be source of efficiency especially in a company level - and many times the only opportunity for practical steps. Therefore practical development cases in container shipping (implemented and potential future initiatives) are analyzed. Container shipping itself can be seen a successful innovation “project” - but originally not particularly organized development project (although governments, standardization instances like ISO etc. have participated in the process). The benefits of container shipping are so obvious that after the slow start the expansion with a positive self-nourishing trend has been rapid during the last decades. In some markets, especially driven by fast developing China and India, container shipping is growing even more rapidly than in advanced and traditionally strong economic areas.

The shipping and stevedoring industry is relatively conservative with large investments made in cargo handling in ports. The rigid physical structures and strong labor union influence decelerate the innovations in the industry. This is not only strategic issue but the inefficiency in cargo handling in the transportation nodes - ports and other terminals – would lead to low utilization of capital investments. However the rate of growth of total factor productivity in ports has been mainly the result of technical change and, to a lesser extent, economies of scale. As the ownership is widespread in transportation services production the compatibility issues between organizations and the solutions to bridge the gaps are getting even more important. The challenges are typically related to different incentives, lack of coordination, part optimization, and inefficiency of individual parties and operations. In port meet several conflicting interests and development trends of transfer chain. Ship sizes have been growing especially in the deep-sea traffic to

achieve scale effects. This a challenge to the port operations for the size of the ship has an influence to the transportation frequency, level of capacity utilization rate, and is dependent on the cargo flow. Finding the most economical combination of the size and cruising and loading speed of a ship on a given route is an intricate question of balancing the investments in shipping technology. Large ships increase the cargo carrying capacity but suffer from longer relative port time, reduced responsiveness to customer needs and low capital productivity under low demand. Hence the new performance should be sought from increased roundtrip frequency of ships. This can be achieved by developing the ship propulsion and hull design or the cargo handling system. The blind spot in shipping is the “unproductive” time such as loading in port that has been ignored because of the pursuit of ever faster and larger ships to intensify the “productive” time at sea.

The economical speed of the ship should be defined together with the cargo handling time at port. It is preferred to choose the port to call according to the offered land connections, port or channel restrictions (cranes available, draught etc.) and capacity. Cargo handling with expensive cranes at shore require strengthened port bank. On-board cargo handling (self-loading/unloading) cranes have traditionally been heavy requiring strengthened, heavy and expensive ship hull. However innovative ship concepts are presented where on-board cargo handling devices are developed to allow higher cargo handling rates with light structure integrated to the ship hull. There are also concepts where the propulsion systems and hull designs have redesigned and thus higher speeds, better fuel economy and maneuvering features have been achieved. As addressed by Vepsalainen et al. (1990) an alternative design could start with the cargo requirements (e.g., fully cellular, self-loading and discharging, and capable of automated handling of container units) and choose the marine technology to best utilize the box structure. This applies e.g. to the presented *Twinstar* concept with on-board cranes and automated container handling. Typically, the capacity of a self-loading ship is limited because of the span of the cranes. The flexibility of service can be improved with automated cargo access (self-loading) that features short span traveling bridge cranes over the length of the vessel for fast container loading and computerized operation. Most stevedoring in lashing and loading is eliminated and the fully enclosed hull provides structural strength, and protects the containers. The low weight achieved (no ramps, gates, gantry cranes or twin-decks) allows high speed at sea. The benefits to customer service quality of such a



ship are fourfold. First, the port operations are fast and independent of port facilities. Second, the speed at sea is fast to any port close to the customers. Third, the cargo is secure with minimal need for labor, equipment, supplies, and maintenance. Fourth, it is possible to customize the service with frequent sailing and flexible routes and low cost (with savings in labor and terminal fees). Taken together, the benefits could promise a high quality of customer service for different distances and for many levels of market demand. However such ships have not been constructed. Possibly *Twinstar* (or similar designs) has been considered not to be innovative enough but a variety of risks related to novel solutions and regulation is involved. On the other hand there are barriers like the existing business practices and the physical structures with long life cycles that tend to stiffen the businesses and prevent to implement such new innovations.

The speed of development in different technological areas, societies and industries is varying. At the same time technological and organizational development change our view of what is possible and therefore raises the expectancies of efficiency in service production in a new level. The development of technology has continued to be rapid since e.g. Muller (1989) put it already fifteen years ago as follows: 'Of all major components associated with transporting cargo, the use of computers in the exchange of data has experienced the most radical change in recent years.' There are significant changes in information systems required but they support advances e.g. in organizing container transfers and help reducing capacity balancing problems with better coordination. One of the promising areas is positioning technologies (e.g. systems based on GPS-technology used in ports in straddle carriers and Rubber Tyred Gantries). Also wireless technologies are getting more popular with the technological advancements (ports with container stacks are still challenging for RF-devices) and are easier and cheaper to implement. A distinction can be made in transfer chain to technologies that are also integrative (enhancing the work between process phases) and to those that are productivity increasing (efficiency increased within a process phase).

New inventions, establishing of innovations and the diffusion of them is a complicated issue and (besides the target organizations) dependent on how the innovation systems in the economic institutions are constructed. In many cases organizational inertia prevents development and the existing physical structures slow down the change. Due to the long

lifespan of basic infrastructure, normally the developments in technology in container transfer change it only in a limited scale. Also some bigger technical entities like ships and port cranes may be used for twenty years with small modifications only; despite of the following product generations would include new innovations. However in construction of new terminals or transportation chains, the latest knowledge and technology can be adopted. Especially in areas with poor infrastructure the barrier for adapting innovations may be low - the current emerging economical areas for example in Asia are benefiting from that. Therefore in some port terminals mechanization or even automation have increased the productivity in cargo handling into new level compared to the previous. There is more powerful and efficient cargo handling machines, innovative equipment for cargo terminal moves and faster and easier to handle cranes available in the markets. A better utilization of land area is also often gained due to the higher stacking height of machinery. As it turns out, proper choices have far-reaching implications not only for customer service but for terminal operations and infrastructure of container shipping and shipbuilding.

The results (e.g. of the case Helsinki West Harbour) show that encouraging improvements can be achieved with realignment of the technological and organizational interfaces also within the current infrastructure of commercial shipping. It is not necessary always however to invest in latest technology but managerial and organizational changes may be enough. Rethinking of the processes - like asynchronous operation for minimizing the disturbance between processes in port cargo handling - increase the efficiency. The SMED (Single Minute Exchange of Dies) System was developed by a Japanese manufacturing expert Shigeo Shingo. One of the key messages of him is that knowing the process we are associated with means understanding why we do it. Minimized set-up times are an important source of increased functionality, speed and productivity within supply chains as well as they have proved to be in manufacturing already earlier. In the Japanese manufacturing systems since the 1950's *internal set-up* (performed only when a machine is shut down) was distinguished from *external set-up* (done while the machine is running) in order to reduce the unproductive machine time (Shingo 1985). Toyota especially is known of applying these approaches in car manufacturing resulting in so called "Toyota Production System". Following Toyota's performance also other car makers have adopted the ideas, as well as companies in

different industries world wide - and also in service sector (e.g. Japan Post). Similarly as it improves manufacturing flexibility, physical transfer chains may gain more flexibility. The increased compatibility and thus achieved connectivity between phases could extend the benefits over the entire transfer chain or networks. In container shipping with unitized cargo the externalized set-up times are benefited in terms of intensified cargo handling. The idea has also been applied in sea transportation e.g. in pusher-barge systems. The expensive part of a ship that includes most of the machinery and technique (pusher) is separated from the inexpensive cargo hold (barge). The target is to maximize the utilization of the pusher that quickly changes barges at the port – leaving the first one for cargo handling and taking the other one that is ready for the sea leg. While the pusher is busy with other tasks the cargo handling of the barge may take place (Laine 1991). Similar concept applied in container shipping in an applicable route could further intensify the capital utilization involved, increase service frequency and balance demand peaks for cargo handling.

## **8.2 Topics of Future Research**

The dissertation has only superficially touched some interesting research topics. During the work several relevant research issues raised that would achieve more proper investigation. Some of the most important of them are addressed in this paragraph.

### **8.2.1 Development Needs of the Transfer Services Matrix**

The Transfer Service Matrix is developed for classification of different transfer types (customer needs or demand) and different transfer channel types (capability to supply). The intention is to be able to position current transfer practices, analyze whether the transfer solutions are produced with efficiency and outline future development directions. The TSM is denoted to high level analysis of transfer services of trends and underlying development drivers. However it can be used also for operational level analyses. It is applicable to e.g. analysis of single phenomenon or relatively detailed level positioning and visualization of service portfolios as have been done in this thesis. In both of these contexts in the analysis of container shipping it has served well as these services could be positioned and visualized in the Transfer Service Matrix. Due to the scope of the TSM

the negotiation stages with customer contacts of the service ordering-supply process were not discussed here. The Transfer Service Matrix covers goods transfer solutions therefore loose raw materials and liquids as well as pipeline transfers were excluded in the investigation.

The applicability of a novel model or framework is of high importance when introduced to the research society. According to Mentzer and Kahn (1995) the researcher should examine and discuss issues of validity, reliability, and precision. Concerning the internal validity of the Transfer Service Matrix the historical effects are the most likely cause to potential re-evaluation required. This may be caused by a general development of technology for example or on the other hand the explosion of physical transfer transaction volumes. This potential problem should be possible to correct by recalibrating the position of the so called efficient diagonal in relation to the axes. Construct validity concerns whether the measures assess what they purport to assess (Mentzer and Kahn 1995). The construct validity is tested in two Master's theses with real life data and business concepts; in express courier and truck transportation services (Rantakokko 2003) and in sea transportation services (Kyllönen 2004). Although the Transfer Service Matrix proved to be challenging to use the results were accepted by the practitioners of the case companies. In the dissertation the applicability of the Transfer Service Matrix is not thoroughly tested in other settings than container shipping and also many of the analyses were conducted in short sea shipping. The applicability in deep sea shipping with different scales in the transfer service portfolios was not tested enough but the challenges are roughly speaking similar. However as the above mentioned case companies form two different areas of physical transfer services (adding the case analyses of this dissertation concerning preferably port operation) it is likely that also the external validity is good. External validity applying to the rest of the results - mainly related to the power in forecasting - of the dissertation supposedly is not a valid problem as nothing certain is claimed about the future. In the dissertation only alternative (even simultaneous) development trends, or scenarios, are presented based on different development forces potentially having influence on the background. There has been intention to develop the Transfer Service Matrix for a more generic analysis of transfer services. However the empiric material within the dissertation was not sufficient enough yet to ensure the applicability in a wider context.

The reliability of the (use of) Transfer Service Matrix is something to be questioned. The utilization of the Transfer Service Matrix proved to be challenging to people other than the author of this dissertation, but required guiding in proper use. Therefore it is potentially difficult to ensure that the Transfer Service Matrix is repeatedly used the same way. Actually however the challenge is more related to the precision of the Transfer Service Matrix. The users of the Transfer Service Matrix have been able to roughly position the services for analyses in the Transfer Service Matrix, but have faced difficulties in fine-tuning. This hardly can be considered a major problem either for the main intention in using TSM is to describe relative position and change. However the further development of the Transfer Service Matrix possibly requires it to be more self-explanatory and more clearly defined. This is related to that the axes of the TSM are not defined e.g. in terms of exact quantitative measures or using a single characteristic but are formulated from several characteristics. Therefore it is not always obvious how the transfer service solutions (as a combination of the type of transfer and channel) should be positioned in the matrix. On the contrary it must be considered which characteristics are the dominating ones in each case. The successful use of the TSM requires general understanding of transfer services, but also relatively detailed information of the transfer services and the related phenomena to be analyzed.

As discussed above the classification and positioning of physical transfer services in the Transfer Service Matrix is not possible based on a single attribute, but the outcome is formed of several aspects. The use of the TSM has to be also verbally described supported with potentially partly intuitive proof. In order to enable more accurate positioning of the elements in both axis and therefore also the solution in diagonal, it would be beneficial to be able to mathematically argue the Transfer Service Matrix. This could be based on costs and cost structures of different channel types and the influence of the different transfer type volumes. A realistic development approach of the Transfer Service Matrix would be based on estimated absolute costs, and the relative share of fixed and variable costs. The classification of the channel in the vertical axis would be based on the relative share of fixed and variable costs. The classification in the horizontal axis would be preferably based on the transaction volumes in each phase of the service. The minimum of the total costs resulting out of these two would then define the optimum solution that - according to the definition - should be positioned in diagonal of

the matrix. The arguing of the Transfer Service Matrix even further and applying it in practical cases in an exact mathematical form could prove to be overwhelmingly challenging. First it would require extensive statistics of the transfer types and detailed information of the costs involved in the channels and additionally the updating would be an extensive challenge. Second the use of it would be troublesome with all the detailed information required.

### **8.2.2 Other Future Research Topics**

The level of integration in interfacing in transfer chains/networks is briefly discussed in the dissertation. The rough division into two was presented here where if frequent changes in the demand are expected, loose relationship between parties is suggested. Respectively if the demand conditions are expected to remain stable, a long-term relationship between parties should be established. This could offer a fruitful subject for further research for depending on the circumstances and types of supply chains, integration should appear in versatile forms. Besides it could bring with it more elements of dynamics into the analyses where the Transfer Service Matrix is used. The words 'integration' but also 'connectivity' is currently handled differently in literature and within practitioners in different context from transactional links to a more strategic level investigation of relationships. Such a study could therefore also clarify the confusing use of the terminology.

Another future research topic is to study deeper in the compatibility challenges addressed in the thesis. Once the compatibility gaps are first detected the central question is how to bridge them systematically in different circumstances during the construction of transfer chain. This would involve for example a more extensive look to standardization and harmonization issues. Such a study could also contribute to the on-going discussion of outsourcing and networking contra vertical integration in supply chains.

## References

- Abrahamsson, Hans (1982) *Spedition*, LiberTryck Stockholm.
- Alderton, Patrik and Rowlinson, Merv (2002) "The Economics of Shipping Freight Markets" in *The Handbook of Maritime Economics and Business*, Grammenos Costas Th. (ed.), LPP, Informa Professional, London, pp. 90-104.
- Anderson, J.E. (1999) *Why do Nations Trade (So Little)?*, mimeo, Boston College.
- Apte, Uday M. and Vepsäläinen, Ari P.J., "High Tech or High Touch? Efficient Channel Strategies for Delivering Financial Services", *Journal of Strategic Information Systems*, Vol. 2, No. 1, March (1993), pp. 39-54.
- Bask, A. and Laine, J. (2000) *Konttikuljetusketjujen Koordinointi - Coordination of Container Transport Chains*, Publications of Ministry of Transport and Communications 46/2000, Finland, 83 p. (in Finnish).
- Benson, Don; Whitehead, Geoffrey; Bugg, Ralph (1994) *Transport and logistics*, Woodhead-Faulkner, New York.
- Bobbitt, Philip (2003) "Wanted: 'forethought' more than forecast" *The Straits Times*: Wednesday, December 10.
- Branch, Alan E. (1982) *Economics of Shipping Practice and Management*, Chapman & Hall, London.
- Brehmer, Per-Olof (1999) *Towards a Model of Lean Freight Transport Operations*, Institute of Technology, Linköpings Universitet, Linköpings Studies in Management and Economics, Dissertations No. 38, 192 p.
- Brooks, Mary R., Blunden Robert G. and Bidgood Cheryl I. (1993) "Strategic Alliances in the Global Container Transport Industry", in *Multinational Strategic Alliances*, ed by Culpán, Refik. International Business Press, an imprint of the Haworth Press, Inc., Binghamton, NY.
- Brooks, Mary R. (2002) "International Trade in Manufactured Goods" in *The Handbook of Maritime Economics and Business*, Grammenos Costas Th. (ed.), LPP, Informa Professional, London, pp. 90-104.
- Bukold, Steffen (1993) "Logistics by Combined Transport: Barriers to Market Entry and Strategies of Main Suppliers" *International Journal of Physical Distribution & Logistics Management*. Vol. 23, No.4, pp. 24-34.
- Button, K. J. (1982) *Transport Economics*, Heinemann, London.
- CEC (1993) *COST 310 - Freight Transport Logistics*, ed. by M.Chapuis, F.Fabre, I. Zubero, Final report of the action, Commission of the European Commission, Directorate-General XIII Telecommunications, Information Market and Exploitation of Research, L-2920, Luxemburg, 89 p.
- Collin, Jari (2002) *Selecting the Right Supply Chain for a Customer in Project Business – An Action Research Study in the Mobile Communication Infrastructure Industry*, HUT

Industrial Management and Work and Organisational Psychology, Dissertation Series No 1, Espoo.

Commission (2001) *White Paper - European Transport Policy for 2010: Time to Decide*, Commission of the European Communities, Brussels.

Containerisation International Yearbook (1996).

Cooper, J., Browne, M. and Peters, M. (1991, 1994) *European Logistics – Markets, Management and Strategy*, Blackwell, Oxford, 1991, 1st ed. & 1994, 2nd ed.

Coyle, John J., Bardi, Edward J., Cavinato, Joseph L. (1990) *Transportation*, West Publishing Company.

Coyle, John J., Bardi, Edward J., Novack, Robert A. (1994), *Transportation*, 4th ed., West-Publishing Company, St. Paul, MN.

Coyle, J.J., Bardi, E.J., Langley, C.J. Jr. (1996) *The Management of Business Logistics*, Sixth Edition, West-Publishing Company, St. Paul, Minnesota. 631 p.

Cullinane, Kevin and Khanna, Mahim (1999) "Economies of Scale in Large Container Ships", *Journal of Transport Economics and Policy*, Volume 33, Part 2, pp. 185-208.

Danielsson, M., Sjöholm, J., Sjöstedt, L. (1991) *Kombitransporter på mellanområden*, Chalmers University of Technology, Department of Transportation and Logistics, TFB-rapport 1991:8.

Davenport, Thomas H. (2005) "The Coming Commoditization of Processes", *Harvard Business Review*, June, pp. 101-108.

Drewry (1997) *Short Sea Container Markets – The Feeder and Regional Trade Dynamo*, Drewry Shipping Consultants Ltd.

Eno (2003) *Intermodal Freight Transport in Europe and the United States*, A Report of the Fifth EU-US Forum on Intermodal Freight, April 11-13, 2002, Jacksonville, Florida, Eno Transportation Foundation, Washington, DC, 78 p.

EU Commission (1999) *Commission Communication on Short Sea Shipping*, COM(99)317 final.

Esko Poltto Oy (1988) *Länsisataman konttinostureiden käyttötutkimus*, Viatek-yhtiöt, June.

Esko Poltto Oy (1993) *Uusi konttinosturi - Sijoitus- ja terminaalijärjestelyt*, Viatek-yhtiöt, December.

Evans, J. J. - Marlow, P.B. (1986) *Quantitative Methods in Maritime Economics*. Fairplay Publications Ltd, London.

Fair, Marvin L., Williams, Ernest W. (1975) *Economics of Transportation and Logistics*, Business Publications, Inc.

Fisher, Marshall (1997) "What is the right supply chain for your product?" *Harvard Business Review*, March-April, pp. 105-116.



- Fomin, V., Keil, T. and Lyytinen, K. (2003) "Theorizing about Standardization: Integrating Fragments of Process Theory in Light of Telecommunication Standardization Wars", *Sprouts: Working papers on Information Environments, Systems and Organizations*, Vol 3, Winter. <http://weatherhead.cwru.edu/sprouts/2003/030102.pdf>
- Forrester J. W. (1958) "Industrial Dynamics: A Major Breakthrough for Decision Makers." *Harvard Business Review* 36 (4): 37-66.
- Goldratt, Eliahu & Cox, Jeff (1986) *The Goal: A Process of Ongoing Improvement*, North River Press, Croton-on- Hudson, NY.
- Goss, R.O. (1965) "The Turnaround of Cargo Liners and its Effect on Sea Transport Costs", *Journal of Transport Economics and Policy*, January.
- Haapanen, Mikko and Vepsäläinen, Ari.P.J. (1999) *Jakelu 2020 Asiakkaan läpimurto*, ed by Bask, Anu H., Gummerus kirjapaino Oy, Jyväskylä, 279 p. (in Finnish)
- Hackett, Ben G. (1994) "Market forecasting and port development", in *World Freight Technology '95*, Sterling Publications International Limited, pp. 171-172.
- Hagman, Thore (1993) "Flexibilitetet, ett hinder för effektivare transporter?" Discussion paper, *NOFOMA 1993 - conference*, Turku, June 10.-11. (in Swedish).
- Harper, Eric (2002) "Adaptive supply chain networks: road to the future at HP company – simplifying IT for superior business results" Presentation at *Sapphire 2002 – Adaptive Supply Chain Networks*, June 6, Orlando, USA.
- Hautaniemi, Petri (1995) *Simuloinnin soveltuvuus sataman maapuolen toimintojen suunnitteluun*, Research Report 85, Lappeenranta University of Technology, Department of Industrial Engineering and Management, Lappeenranta (in Finnish).
- Hayes, R.H. and Wheelwright, S.C. (1979) "Link Manufacturing and Process and Product Life Cycles", *Harvard Business Review*, January-February.
- Hilmola, Olli-Pekka, Hejazi, Annukka and Ojala, Lauri (2005) "Supply chain management research using case studies: a literature analysis" forthcoming in *International Journal of Integrated Supply Chain Management*.
- Holmström, Jan (1995) *Realizing the Productivity Potential of Speed*, Acta Polytechnica Scandinavica, Mathematics and Computing in Engineering Series No. 73, Helsinki.
- Jansson, J.O., Shneerson, D. (1987) *Liner Shipping Economics*. Chapman and Hall Ltd, London.
- JSEA (1993) "Totally Enclosed Forest Carrier", in *Shipbuilding and Marine Engineering in Japan 1993*, Japan Ship Exporters' Association, pp. 96-97.
- Kent, J. and Flint, D. (1997) "Perspectives on the Evolution of Logistics Thought", *Journal of Business Logistics*, Vol.18, No.2, pp.15-29.
- Kim, M. and Sachish A. (1986) "The Structure of Production, Technical Change and Productivity in a Port." *The Journal of Industrial Economics*, Vol. 35, No. 2, December, pp. 209-223.

- Klaus, P. and Mueller-Steinfahrt U. (1994) "The Diffusion of Logistics in Large Organizations: Playful Ways Towards a Serious Goal", in *Logistics at the Crossroads of Commerce*, The Transportation and Logistics Research Fund, The Ohio State University.
- Kondratowicz, Ludwik J., Ojala, Lauri (1991) "Simulation of Intermodal Freight Terminals", *NOAS 91 - OR in Business*, Turku, Finland, August 22-23.
- Kopczak, Laura.R., Lee, Hau and Whang, Seungjin (2000) "Note on Logistics in the Information Age", Graduate School of Business Stanford University, Case Number: GS19, May.
- Kumar, Shashi and Hoffmann, Jan (2002) "Globalisation: The Maritime Nexus" in *The Handbook of Maritime Economics and Business*, Grammenos Costas Th. (ed.), LPP, Informa Professional, London, pp. 35-62.
- Kyllönen, Helena (2004) *Development of Sea Freight Transportation in the Baltic Sea Region*, Master's Thesis, Helsinki School of Economics, Dept. of Marketing, Logistics, Helsinki. (Unpublished, in Finnish).
- Laine, Jouni (1991) *The Improving of Efficiency of the Raw Material Transportation at the Baltic Sea – The comparison of pusher-barge system and conventional vessels*, Master's Thesis, Helsinki University of Technology, Faculty of Mechanical Engineering, Espoo 16th May (Unpublished, in Finnish).
- Laine, Jouni (1998) *Managing Technological Resources and Port Operations in Container Shipping*, Licentiate Thesis, Helsinki School of Economics and Business Administration, Dept. of Marketing, Logistics, Helsinki (Unpublished).
- Laine, Jouni T., Vepsäläinen, Ari P.J. (1994) "Economies of Speed in Sea Transportation" *International Journal of Physical Distribution & Logistics Management*, vol. 24, number 8.
- Lee, H., Padmanabhan V., Whang, S. (1997): "The Bullwhip Effect in Supply Chains", *MIT Sloan Management Review*, Spring, 93-102.
- Lee, Hau L. and Whang, Seungjin (2001) "Winning the Last Mile of E-Commerce" *MIT Sloan Management Review*, Summer, Vol 42, Issue 4, p. 54
- Levander, K. (1993) "The potential for fast ships in European freight transport" in *European Shortsea Shipping*, Proceedings from the First European Research Roundtable Conference on Shortsea Shipping, 26-27 November 1992, Technical University Delft, The Netherlands. Lloyd's of London Press Ltd.
- Linde, H. (1991) "Technological and Operational Development in Marine Container Transport" in *Third Conference on shipping Cooperation and competition in the Common European Home*, Rostock, June, 12th-14th, pp. 35-55.
- MacFarlane, Roger I. (2004) "A CEO's view of Global Supply Chain Management" in *Asia – Where the Supply Chain Begins...* Council of Logistics Management, Asia-Pacific Conference, Singapore, 1-2 March.
- Magnier, Mark (1988) "What Innovations Are in Store For Intermodalism in the U.S.?", *Journal of Commerce*, 9/23/1988, pp. 1A & 10A.

- Marine Log (1988) "APL's President Truman—First C10", June, pp. 52-56.
- Martin, M.J.C. (1984) *Managing Technological Innovation & Entrepreneurship*, Reston Publishing Company, Reston, VA.
- Meersman, Hilde and Van der Voorde, Eddy (2001) "International Logistics: A Continuous Search for Competitiveness", in *Handbook of Logistics and Supply Chain Management*, A.M. Brewer, K.J. Button and D.A. Hensher (eds.), Oxford, Pergamon Press, pp. 61-77.
- Mentzer, J. and Kahn, K. (1995) "A Framework of Logistics Research", *Journal of Business Logistics*, Vol.16, No.1, pp. 231-249.
- Ministry of Transport & Communications, Finland (1998) *Kuljetusketjujen toiminnan- ja teknologiankehittämisohjelma* (Transport Chain Development Program), in Finnish, Report B2/1998, Oy Edita Ab, Finland.
- Miser, Hugh J. & Quade, Edward S. (1988) "Validation" in *Handbook of Systems Analysis; Craft Issues and Procedural Choices*. (Ed.) Miser, Hugh J. & Quade, Edward S., John Wiley & Sons, Chichester.
- Muller, Gerhardt (1989) *Intermodal Freight Transportation*, Second Edition, Eno Foundation for Transportation.
- Muller, Gerhardt (1999) *Intermodal Freight Transportation*, Fourth Edition, Washington DC: Eno Transportation Foundation and Intermodal Association of North America.
- Musso, Enrico and Marchese, Ugo (2002) "Economics of Shortsea Shipping" in *The Handbook of Maritime Economics and Business*, Grammenos Costas Th. (ed.), LPP, Informa Professional, London, pp. 280-304.
- Navigator (1993) "Euroopan yhteisön satamapolitiikka muotoutuu lyhyin askelin" Navigator 6/1993.
- Noori, Hamid (1990) *Managing the Dynamics of New Technology: Issues in Manufacturing Management*, Prentice Hall, New Jersey.
- Ocean Shipping Consultants (1995) *Market Prospects for European Containerisation*, Chertsey.
- Oda H. (1991) "The means of restoring the balance in the container market while improving market efficiency", in *Third Conference on Shipping Cooperation and Competition in the Common European Home*, Rostock, June, 12th-14th, pp. 30-34
- Ojala, L. (1991) *Strategic Management of Port Operations, A Theoretical Review of the Concepts of Strategic Management with Some Practical Applications to Main General Cargo Ports in Finland*, Publications from the Center for Maritime Studies University of Turku, A 8.
- Page, Mark (2004) "World container trade growth and liner shipping activity - the short to mid-term outlook" *TOC 2004 Asia, Serving Asia in the coming decade: Building capacity and operational efficiency*, Singapore 2-4 March.

Pearson, Mark and James, Philip (2002) *The Intelligent Supply Chain*. Logistics Europe, February.

Port of Helsinki (1994), *Manual 1994*.

Porter, Michael E. (1985) *Competitive Advantage: Creating and Sustaining Superior Performance*. N.Y.: Free Press, (Republished with a new introduction, 1998).

Rantakokko, Tiina (2003) *Customer Interface Management in Efficient Transport Service Production – Case DHL*, Master's Thesis, Helsinki School of Economics, Dept. of Marketing, Logistics, Helsinki (Unpublished, in Finnish).

Russell, Roberta S. and Taylor III, Bernard W. (1998) *Operations Management – Focusing on Quality and Competitiveness*, Second edition, Prentice-Hall, Inc., New Jersey.

Schmenner, R.W., (1997) *Plant and Service Tours in Operations Management*, 5th ed., Prentice-Hall, Inc., New Jersey, NJ.

Seppälä, Ulla (1997) *An Evolutionary Approach for Locating Economic Facilities*, Acta Polytechnica Scandinavica, Mathematics and Computing in Engineering Series No. 83, Espoo.

Shingo, Shigeo. (1985) *A Revolution in Manufacturing: The SMED System*. Productivity Press: Cambridge, Massachusetts and Norwalk, Connecticut.

Silvestro, R., Fitzgerald, L., Johnston, R., and Voss, C. (1992) "Towards a Classification of Service Processes", *International Journal of Service Industry Management*, Vol. 3 No. 2, pp. 62-75.

Siong, Neo Boon; King, John and Applegate, Lynda M. (1995) "Singapore TradeNet: Beyond TradeNet to the Intelligent Island", *Harvard Business Case Studies*.

Stern, Louis W. and Heskett, James L. (1969) "Conflict Management in Interorganizational Relations: A Conceptual Framework", in Louis W. Stern (ed.), *Distribution Channels: Behavioural Dimensions*, Boston: Houghton Mifflin Company, pp. 288-305.

Stopford, Martin. (1990) *Maritime Economics*, Unwin Hyman Ltd, London.

Talley, Wayne K. (1986) "A Short-Run Cost Analysis of Ocean Containerships", *Logistics and Transportation Review*, Vol. 22, No. 2, June, pp. 131-139.

Tan, Albert and Gwee, Seng Kwong (2002) "Business-to-Business Electronic Commerce: Challenges and Solutions" in *From Edi to Internet Commerce in Supply Chain Management: The Singapore Experience*. Published by Idea Group Publishing.

The Motor Ship (1987) "Self-discharging container ship can use smaller ports." *The Motor Ship*, Vol. 68, No. 809, December, p. 25ff.

The Port of New York Magazine (1932) "Seatrains: Speedy Ocean Freight Car-Carriers, Open New York-Cuba Service", *The Port of New York (magazine)*, September, pp. 19-21.

The Straits Times (2004) "Containing Torjan Horse" *The Straits Times*, Wednesday, December 8, 2004, p. 24.

The Straits Times (2005A) "2004 a record year for PSA Singapore" *The Straits Times*, Wednesday, January 12, 2005, p. 3.

The Straits Times (2005B) "Record volumes last year at Pelepas port" *The Straits Times*, Wednesday, January 19, 2005, p. H18 /*Bloomberg News*.

Tinnilä M. (1997) *Division of Service and Business Processes*, Helsinki School of Economics and Business Administration publications A-132, Ph.D. Thesis.

Tompkins, James A. (2001) "Last Mile is The Toughest" *Food Logistics*, 7/15/2001, Issue 43, p. 60.

Transport & Hantering (1992) "Ahlmarks unika höglagerskepp sänker kostnaderna med 30-40%." *Transport & Hantering* 9/92, pp. 31-32.

U.S. Department of Commerce (1980) *National Port Assessment 1980/1990, An Analysis of Future U.S. Port Requirements*, U.S. Department of Commerce, Maritime Administration, Office of Port and Intermodal Development, June.

Vafidis, Dimitrios (2003) "Methodological Choices of 25 Finnish and Swedish Logistics Dissertations 1994-1998", in *Case Study Research in Logistics*, Ojala L and Hilmola O-P (editors), TuKKK B-1:2003, pp. 157-182.

van Damme, D.A. and van Amstel, M.J.P. (1996) "Outsourcing Logistics Management Activities" *The International Journal of Logistics Management*, Volume 7, Number 2.

Vepsäläinen, A., Nordstrom, I.R., Nordstrom R.R. (1990) "Quality of Customer Service - The Challenge for Container Shipping", SNAME, Ship Operation, Management and Economics Symposium, April 26, pp.11.1-11.4.

Viswanadham, N. and Gaonkar, Roshan (2002) *Foundations of E-Supply Chains*, The Logistics Institute – Asia Pacific, National University of Singapore, 6 p.

Vuorinen, Marko (1998) *Helsingin tavarasatamien kapasiteettiselvitys 1997*, TTL-Logistiikka, Helsingin sataman julkaisu, sarja C, 98:1, June 15.

Wijnolst, N., van der Hoeven, H.B., Kleijwegt, C.J., Sjöbris, A. (1993) *Innovation in Shortsea Shipping: Self-Loading and -Unloading Unitload Shipsystems*, Delft University Press.

Wijnolst, N., Sjöbris, A., Peeters, C., Verbeke, A., Declercq, E., Schmitter, T.J.N. (1994) *Multimodal Shortsea Transport Coastal Highway - Indispensable (and Free) Link in the European Transport Network*, Delft University Press.

Williamson, Oliver E. (1985) *The Economics Institutions of Capitalism*. The Free Press, New York, NY 10020.

World Bank (2001A) *Port Reform Tool Kit, Module 1, Framework for Port Reform*, World Bank, 26 p.

World Bank (2001B) *Port Reform Tool Kit, Module 3, Structures and Ownerships Models*, World Bank, 77 p.

Woxenius, Johan (1993) *Enhetslaster - teknik, ekonomi och historia*, Chalmers University of Technology, Department of Transportation and Logistics, Göteborg (in Swedish).

Yamada, Hideo (1990) *Strategy of Shipping Companies for International Physical Distribution*, Japan Maritime Research Institute, JAMRI Report, No. 39 December.

Yin, Robert K. (1994) *Case Study Research – Design and Methods*. California: SAGE Publications, 2<sup>nd</sup> ed., Thousand Oaks, 171 p.

Yin, Robert K. (2003) *Applications of Case Study Research*, Applied Social Research Methods Series, Volume 34, California: SAGE Publications, 2<sup>nd</sup> ed., Thousand Oaks, 173 p.

Zachcial, M. (1996) “Land/Sea Transport Flows in Europe” in *Conference Papers, Third European Research Roundtable Conference on Shortsea Shipping*, 26-27 June 1996, Bergen, Norway. Delft University Press.

### **Brochures, presentation materials and other publications:**

Andersen Consulting (2002) Presentation material 2002.

Dyna Liners (1996), *Dyna Liners*, No. 10/1996, Weekly News Summary and Commentary on Liner Shipping, Dynamar BV, Shipping Information and Consultancy, 8 March.

Opening Delta/Sea-Land Terminal (1992), a special magazine by Revue Arts Publishers, Den Haag.

### **Internet pages:**

Containerships Ltd. Oy website: ([www.containerships.fi](http://www.containerships.fi)).

International Maritime Organization, IMO. Online, available at: ([www.imo.org](http://www.imo.org)) [4 June 2004].

ISO (International Organization for Standardization). Online, available at: ([www.iso.org](http://www.iso.org)) [3 June 2004].

OOCL (2004). Online, available at: <http://www.oocl.com/press/2004/26Jan2004htm.htm> [4 February 2004].

Patrick Corporation (2003). Online, available at: <http://www.patrick.com.au> [10 December 2003]

RosettaNet (<http://www.rosettanel.org>).

Supply Chain Council (SCC) ([www.supply-chain.org](http://www.supply-chain.org)).

### **Interviews:**

Anonymous industry player (Senior Vice President) [6 April 2004].

Boe, Abraham (Director), Bell Terminal Rozenburg, Netherlands, [27 September 1994].



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