Customer managed intermodal transport solutions: why, how, for whom?

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Abstract: The study investigates development of new intermodal transport solutions with specific focus on solutions where customers, the shippers, choose to develop and manage their own intermodal solutions instead of buying the transport service in the market. The purpose of the paper is to study the design aspects of customer managed intermodal transport system development to see what makes such systems competitive. Focus is on why shippers develop such solutions; how they solve fundamental performance problems; and what characterises such shippers. Shippers engage in development and management of intermodal solutions based on perceived weak signals about future threats and opportunities. Intermodal solutions are designed to meet cost, quality, and environmental requirements. Shippers engaging in development of such solutions have large and concentrated flows. Furthermore, they have strong environmental policies, and are highly dependent on efficient transport. Finally, they are major buyers in the transport market having previous experience in using rail/intermodal.

Keywords: intermodal transport; shippers; performance; case study; transport strategy; cost advantage; transport quality; sustainable transport; intermodal transport solutions; customer managed transport solutions; shipper developed transport systems; transport performance; STRA theory.

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1 Introduction

Historically, intermodal door-to-door transport services in Europe have been supplied through traditional market exchange processes in which shippers have bought the services they need from carriers in the market place. This holds also for more permanent transport solutions, the aim of which is to satisfy the need for transport on a regular basis from suppliers to manufacturing and trading companies or from the latter to their customers. However, during the last decade another phenomenon has appeared in which customers, the shippers, when they replace an existing transport solution with an intermodal one, choose to develop and run their own intermodal transport solution instead of buying the service in the market place. We will refer to these as *customer managed intermodal transport solutions* (CUMITS). They are defined here as intermodal transport solutions created through a process in which the customer/shipper initiates and designs the solution during a development process and manages the solution once it has been implemented.

These solutions consist of one or a few intermodal transport chains. An intermodal transport chain is a sequence of transport links for the movement of goods in intermodal loading units (ILUs) between points of origin and points of destination where the load units are transhipped at least once from one mode of transport to another during the movement. An intermodal transport chain will always contain a link for the main consolidated, long distance haulage together with links for either pre-haulage or post-haulage or both. A transport chain is a system. We will therefore use the term intermodal transport system as a synonym, particularly if a solution consists of more than one chain or if we want to stress technological/managerial aspects of a solution. The ‘S’ in CUMITS can, thus, be interpreted as either ‘solution’ or ‘system’.

The intermodal transport chains considered in this paper consist of either main haulage by rail surrounded by pre-haulage and post-haulage by truck or main haulage by ship surrounded by pre- and post-haulage by rail or truck or both. An important property of an intermodal transport chain is that each link in the chain can be modelled as consisting of closed cyclical movements of vehicles, vessels and load units.

The design phase of the shipper when developing an intermodal transport system may involve the following:

- choice of physical transport system components such as trucks, trains, rail cars, ships, ILUs (containers, swap bodies, trailers), and handling equipment (fork lift trucks, cranes)
- choice of infrastructure for traffic flows such as terminals and links for road, rail and sea traffic
- choice of organisational structure of carriers and other actors to collaborate with and the rules for such collaboration
- finally, depending on the kind of supply chain in which the intermodal transport system will be integrated, there will be some need for developing information and decision systems for managing the transport flows according to supply chain objectives.

This description indicates that the development of customer managed intermodal transport systems is a complicated, resource demanding, and risky activity. It is therefore conspicuous and somewhat surprising that shippers choose to become their own suppliers of intermodal transport solutions. The development of CUMITS involves significant and long-term investments of money and effort. If it becomes a failure, serious disturbances in supply chains from suppliers or to customers may occur. Therefore it will be analysed in this paper as a response to strategic problems. The new phenomenon of CUMITS lacks attention in intermodal transport research. This is unfortunate since the shift to intermodal transport from road transport in Europe is high on the agenda from industrial, national, and supranational perspectives.

The entire development process from system initiation to system implementation deserves attention in research regarding questions about *why*, *how*, and *who*? The purpose of the present paper is specifically to study the design aspects of customer managed intermodal transport system development to see what makes such systems competitive. We will restrict our attention mainly to the following research questions:

- Why do shippers develop CUMITS?
- How do they solve fundamental performance problems of intermodal transport systems?
- What characterises these shippers?

Within this context we have two objectives: to describe empirical aspects of CUMITS and to develop theoretical frameworks related to the research questions.

2 Related literature

The problems of the existing supply of intermodal transport services have received some attention from a general perspective in the literature. PROMIT (2007), EC (2003), Krueger (2005), Amrie (2007) and Kreutzberger et al. (2003) refer to problems with poor quality and high costs. PROMIT (2007) and Woodburn (2006) observe poor information flows as an issue, and EC (2003), Amrie (2007) and IQ (2000) find restrictions on the type of goods that can moved. However, these studies do not deal with CUMITS and the research questions we have formulated, but taken together they indicate the existence of market failures or market imperfections, at least for certain categories of shippers.

3 Methodology

Our research approach is a multiple qualitative case study of three major Swedish shippers that have been involved in development processes and are currently managing their own intermodal transport solutions. The selection of cases has been based on their relevance and their ability to give access to empirical data. In all three cases, at least one end-point of the intermodal solution is situated in the Scandinavian Peninsula, thus exposed to partly similar institutional environments. Since answering the research questions posed above requires understanding the internal rationale of companies and their actions, the case study is found to be a suitable methodology. Moreover, to avoid excessive focus on aspects that are contextual rather than generic, a multiple case study methodology is chosen. In-depth semi-structured interviews have been carried out with staff involved in the development/management of the studied intermodal solutions. The Appendix describes the structure of the interviews and the questions asked.

In our approach, theory has a dual significance. We develop a conceptual framework used instrumentally as a guide for designing the study in terms of formulation of key problems and interview questions and for structuring the analysis of collected data. A second use of theory in our approach is the identification of concepts and theories reflecting empirical discoveries made in our case studies. The aim of the latter is to get some input for theory development. Our study thus contains both deductive and inductive elements.

4 Conceptual framework

Jensen (2008) has developed a general conceptual framework for the design and evaluation of intermodal transport systems from a strategic perspective. In order to be successful according to this framework, a proposed intermodal transport system must first of all possess a significant, sustainable competitive advantage (SSCA) and, given this, it must also have sufficient market entry ability (MEA). SSCA refers to a unique combination of properties that allows the system to provide an output with a cost/service ratio that is preferred by customers/users over the closest competing alternatives. ‘Significant’ means that the difference is big enough and ‘sustainable’ that it will last for a sufficient period of time. Otherwise, customers will not change their existing transport solutions. When evaluating the SSCA of a proposed system, cost advantage, environmental advantage, and transport quality advantage are decisive strategic performance dimensions. A sufficient criterion for SSCA of a proposed system over a reference system to exist is that the proposed system shows a significant sustainable advantage in one of the performance dimensions and is at least as good in the other two. The reference system will normally be the existing system at present or a predicted future state of the existing system.

According to Jensen (1990), scale advantages of intermodal transport chains derive mainly from capacity utilisation of each transport cycle performed by trains, ships, and trucks in the different transport links along the chain and, given this, also from the capacity utilisation of each link in terms of number of transport cycles per link. In cost terms the scale advantages depend on the existence of fixed traceable cost per cycle operation and per transport link and also on an overall fixed common chain cost.

Departing from this we define here economies of scale and economies of balance. If V is the sum of freight volumes in both directions of a given chain and B a measure of flow balance, then the average cost per unit of cargo (or per ILU) one way will be a decreasing function f(V, B) of V and B. Specifically, for a given V, the unit cost will decrease with increasing balance. We will use the terms economies of scale and economies of balance for the average unit cost dependency on V and B, respectively, for the entire chain. One of the objectives of intermodal transport system design is to maximise cost advantage by deploying economies of scale and balance. These two concepts are highly relevant to intermodal system optimisation.

We also define economies of distance. Suppose that we consider a given freight flow between end terminals in transport systems that are identical in all relevant respects except for the distance D between their end terminals. Economies of distance refer to the decreasing average cost per ILU-km (or goods ton-km) as a function of D. This concept is useful as a general characteristic for comparing transport solutions, e.g., when comparing intermodal solutions with road-based transport since the latter is weak in terms of economies of distance.

Sjöstedt et al. (1994) define two concepts of relevance for describing strategies for improving, in particular, the economies of balance of transport systems: technological openness and commercial openness. Technological openness refers to the ability of a system to accept other technologies than those used by the 'owner' of the system such as different ILUs. A system is commercially open if unused capacity can be sold to customers or used by other actors than the system owner.

By analogy, the environmental advantage of a given chain can be defined in efficiency terms such as average environmental impact per ILU or unit of cargo. Since there are several possible environmental dimensions, a single one has to be chosen such as CO2 emissions. An alternative is to define a composite measure. In a broad sense, environmental impact is negatively correlated with capacity utilisation of vehicles, vessels, and load units. However, occasionally the concept of environmental advantage will have to cover more than emission related impacts. Intermodal transport is environmentally more favourable than road transportation (Kreutzberger et al., 2003).

Jensen (2008) defines nine transport quality dimensions for the service output from an intermodal transport system. These dimensions, shown in Table 1, are used as an exhaustive set for representing quality advantage in this paper. Not all dimensions will be relevant when evaluating a specific case, since relevance is dependent on the supply chain to which the transport system belongs. We prefer the term *regularity* instead of *reliability*, since *reliability* can be associated with other quality dimensions than time as well.

Table 1 Quality dimensions of intermodal transport systems

Quality dimension	*Definition*
Transit time	The total time it takes for an ILU to move from its point of origin to its destination
Regularity	Ability of a chain to keep promised transit times (often termed 'reliability').
Frequency of service	Number of departures per unit of time from origins offered by a chain
Goods comfort	Protection of the goods against damage during transport
Security	Protection of goods against theft during transport
Controllability	Possibility for shippers and consignees of following the transport process with regard to deviations from schedule
Flexibility	Ability of a transport chain to adapt to changes or specific goods requirements in the pre- and post-transport systems
Detachability	Ability of a transport chain to allow shippers and consignees to release physical and administrative handling resources from the departure and arrival of ILUs
Expandability	The ability of the chain to facilitate the integration of ILUs into the pre- and post-transport processes for logistics or manufacturing purposes

5 Case descriptions

5.1 Coop

Coop is the second largest grocery retail chain in Sweden with more than 760 retail stores and three warehouses. Coop accounts for 21.5% of the entire Swedish grocery retail sector. Coop has a dedicated intermodal solution combining Coop's inbound flow from suppliers (manufacturers, wholesalers) to Coop's main warehouses, and outbound flow from the warehouses to Coop stores in the south of Sweden (through cross-docking terminals and directly to hypermarkets). The solution covers the following product groups: dry, chilled, and frozen foods (fruits)[1]. Coop Train is a purely domestic solution combining rail and road transport with semitrailers as ITUs. The solution has been in use since 2009 and is dedicated to Coop cargo only. The new intermodal solution was implemented together with restructuring of the distribution network and rewriting of contracts with suppliers.

Coop operates in an industry, where environmental issues are of increasing importance. Moreover, environmental leadership has become an important factor in highly competitive industries with similar product range. In 2007 Coop formulated its quantitative environmental goal: "Coop's objective is to cut greenhouse gas emissions by at least 10% by 2010 and by at least 40% by 2020 compared to the level of 2008".

5.2 Volvo

Volvo Group is one of the world's leading manufacturers of trucks, buses, construction equipment, drive systems for marine and industrial applications, and aerospace components. The development work and management of the intermodal solution studied in this paper has been done mainly by Volvo Logistics – a business unit[2] in Volvo Group providing services for the automotive industry (mainly internally).

The intermodal transport solution is dominated by inbound transport in the northbound direction from component suppliers in Germany to assembly plants for Volvo Group and Volvo Car Corporation in Sweden. The flow in the opposite direction consists mainly of packaging material back to suppliers. This flow is smaller. To optimise the utilisation, part of the southbound capacity is sub-contracted to two road hauliers that have been contracted for pre- and post-haulage. The solution was implemented in 2008.

Environmental care is one of the three core values of Volvo Group, It is integrated into all activities, including procurement, which transport is part of. In 2006, Volvo Logistics was given a challenge from Volvo Group top management to reduce CO2 emissions by 20 % by 2010 from land transport in Europe.

5.3 Stora Enso

Stora Enso is one of the world's leading paper and pulp manufacturers. Stora Enso has a dedicated intermodal transport solution based on the combination of rail and sea transport for the outbound transportation from paper mills in Sweden and Finland to markets in continental Europe (and overseas). The development work and management of the solution has been done by Stora Enso Distribution and Transport, an internal logistics unit. As a major change, the solution involved the design of new specialised loading units that would enable protection of cargo and high capacity utilisation per ILU. Stora Enso's transport needs are mainly southbound for finished products. In the northbound direction, part of their system is used for transporting certain materials to the mills. In addition, capacity on the vessels is managed by a contracted vessel operator, who sells out empty capacity to third parties. The solution was initially implemented in 1997, but has gone through a process of expansion due to the merger of the Swedish company with a Finnish company and the consequent integration of the transport solutions for both countries.

Similarly to Volvo and Coop, Stora Enso is a company with a strong environmental profile.

6 Why shippers develop customer managed intermodal transport systems

Our empirical observations indicate that the change to a customer managed intermodal solution can be understood in terms of strategic threats (T) or opportunities (O) and that the decision is made in two logically separate steps. In a first step, intermodal transport is found to be a solution, and in a second step, when met by the failure of the intermodal market to offer satisfactory solutions, the case companies decide to develop customer managed intermodal transport systems.

6.1 Change to intermodal solution

6.1.1 Empirical observations

In the case of Volvo, the most important threat derives from expected government measures and regulations against the increasing environmental impact from continued road-based transport in Europe. Other perceived threats originating from continued road-based transport are cost disadvantages from increasing costs of fuel, road tolls, and delays from traffic congestion, mainly in Germany, and also the risk of material flow disruptions or delays due to scarcity of truck drivers.

In the case of Stora Enso, the threats originate in the predicted strategy of Deutche Bahn (DB) after the fall of the Berlin Wall to give priority in terms of price and capacity to traffic on the east-west axis instead of the north-south axis. Since the main markets of Stora Enso require transport in the north-south direction, the predicted DB strategy was perceived as a future threat to the efficiency and effectiveness of Stora Enso's system for distribution to end customers in central and southern Europe, which was based on a traditional railway solution using wagon load traffic. This solution was also perceived to be sensitive to volume fluctuations and having a high risk of damage to goods.

In the case of Coop, CO2 emissions and other environmental impacts from continued road transport represent a threat to the company's overall environmental policy, which is an important component in the Coop brand. Adopting an intermodal solution can be seen as a strategy for creating a fit between the transportation strategy and the company's overall environmental strategy.

Moreover, in all three cases top management has been involved in the decisions about, or approval of, the new intermodal solutions. In the cases of Coop and Volvo, the choice of intermodal solutions were decisions made for reaching predetermined quantitative environmental objectives of the companies, while in the Stora Enso case, the intermodal solution was also seen as a major and natural supportive component to the overall environmental profile of a company in the forest industry. These two examples also illustrate how the intermodal solutions have been dealt with on the highest level in the companies and have been treated as strategic issues.

Our empirical study stresses two aspects of contemporary transportation. The first one is the importance of the firms' transport functions. Particularly in companies where complex flows of material or components travel long distances between suppliers and factories and/or product flows travel long distances between factories and customers, efficient and effective transportation is a vital strategic ingredient in corporate competitiveness. Transportation has increasingly become of high strategic significance to firms. The second aspect concerns how the firms' transport functions respond to external signals from the changing macro and meso environments. In this respect, modal change to intermodal solutions are becoming increasingly common, particularly in large enterprises having heavy or complicated logistics flows over long distances.

6.1.2 Theoretical explanations of the change to intermodal

The decisions of the case companies to change to intermodal transport solutions can be interpreted as strategic responses to weak signals. They fit well into the generic model or scheme presented by Ansoff (1984). Weak signals are defined here as a situation where there is a sense of threat/opportunity (T/O) and the source of T/O is known or partly known, but the shape of T/O is rather incomplete.

These signals represent strategic threats to shippers in scenarios assuming continued use of present transport solutions. There is a sense of threat from expected Government measures against the greenhouse effect and other environmental impacts and also from increasing and changing freight flows in Europe. The source of threat is known. The source is continuation of the companies' existing transport solutions in a changing company environment (road transport in the case of Volvo and Coop and wagon load railway transport in the case of Stora Enso). The shape of the threats is incomplete. The shape can only be described in rather vague and general terms such as threats to certain logistics resource advantages and thereby to the competitiveness of these companies. Threats mentioned in general terms by the case companies are: Scarcity and higher prices in some markets for logistics production factors; blockages in the companies' distribution or supply systems due to changing traffic patterns or increasing traffic intensities, as well as an eroding impact on company environmental image from the continued use of road transport. The latter represents conflict between company transport strategy and company brand strategy.

In a generic sense, the observed strategic behaviour of the three case companies can be explained by a slight extension to transportation of generic resource advantage theory (RA theory) as described by Hunt and Morgan (1995) and Hunt (1999). The change to intermodal solutions seems to be caused by the perceived threats against the future supply of transport resources that are vital to the efficient and effective flows in the logistics supply chains of these firms and thereby also against the competitiveness and long run survival of the firms. According to our study, the supply chains are expected to be better protected or even made more efficient and effective basing transport on intermodal solutions. We suggest the term strategic transport resource advantage theory (STRA theory) for this explanative contribution to the theory of transport strategy.

By an early change to intermodality, the case companies hoped to gain a first mover advantage in getting access to new resources such as desired track slots in the railway infrastructure, thereby becoming less dependent on other resources which were predicted to rather quickly become in short supply, such as truck drivers. The strategic aspects of the concept of first mover advantage have been dealt with by Porter (1985) and D'Aveni (1995)

The change to intermodal transport can be explained also in terms of uncertainty reduction since a change to intermodal solutions are perceived by the respondents to be able to absorb some of the strategic uncertainties that would be inherent in the continued use of their companies' existing transport solutions.

6.2 Customer managed intermodal transport solution

The decision of the case companies to develop and keep the intermodal solution 'in house' is explained by two factors:

- Lack of acceptable offers in the market place in terms of system performance – market failures.
- The case companies' expectations about a promising performance potential of intermodal transport solutions when designed and managed to take advantage of specific customer characteristics and to meeting specific customer requirements. Moreover, as intermodal systems were perceived as more complicated and vulnerable, preserving control over the system has been seen as a benefit.

6.2.1 Empirical observations

The prime reason for choosing a customer managed intermodal transport solution seems to be that this type of system was expected to give an acceptable performance combination in the cost, environmental, and transport quality dimensions. Since the environmental advantage was expected to improve given a change to a reasonable, but not completely known, intermodal solution as such, the choice to develop the system 'in house' was determined by the expected outcomes in the cost and quality dimensions.

In the Volvo case, transport quality is the decisive factor. The assembly operations in the Volvo factories, partly requiring 'just in time' and 'in sequence' deliveries, are very sensitive to deviations in regularity. The regularity offered by the market solutions were not considered safe enough, but also the flexibility, detachability and expandibility of the available intermodal market solutions were regarded as inferior.

In the Stora Enso case, the strategic objectives in the environment, cost and quality dimensions could not be fulfilled by a market solution. The main reasons are that the existing intermodal solutions offered by the market were unable to provide load units of sufficient size and shape to hold big paper reels and that the sellers of the existing market solutions were expected not to have sufficient power to avoid predicted traffic blockages in the German railway system. In conceptual quality terms, neither the flexibility nor the regularity offered by existing market solutions was expected to fulfil the requirements of Stora Enso.

In the Coop case, the main reason for developing a customer managed intermodal transport solution is to be found in the predicted risky regularity performance of existing market-based solutions, together with their inability to function as an effective communication channel for the promotion of a company specific environmental image. For the company's environmental image to be effectively enhanced by intermodal transport, two aspects are important. Firstly, it was considered necessary to control load units so that they can be used to mediate promotional messages by texts, colours, pictures and logotypes. Secondly, it was considered to be an advantage to control trains, since unit trains carrying only Coop ILUs were assumed to communicate promotional messages more effectively than mixed trains. The control of trains was impossible to get in a market-based solution. At the time when the decision was made to initiate the Coop Train, Coop Logistics was involved in a project aiming at evaluating a collaborative intermodal solution involving several retail chains. However, the top management of Coop decided to choose a company specific solution.

6.2.2 Theoretical explanations

The Jensen (2008) framework does a good job in explaining the decision to develop customer managed intermodal transport systems. According to this framework, significant, SSCA of a transport system will be determined by the outcomes in three performance dimensions: Cost advantage, environmental advantage, and transport quality advantage. In order to be preferred, a new system must perform significantly better in one dimension and at least as good in the remaining two. The solutions offered by the market did not fulfil this criterion for SSCA for the case companies. The market-based solutions were considered to represent improved environmental advantage, but at the same time they were expected to be inferior in terms of cost or quality performance or both. Therefore, the regular market for intermodal transport solutions was deemed unable to provide solutions promising SSCA.

7 How did the case companies solve fundamental performance problems?

As developed in the conceptual framework of this paper, the success of transport system design is a question of creating a new system with preferred performance over the existing transport solution. The criterion requires the new intermodal system to show a significant sustainable advantage in one of the three dimensions of cost advantage, environmental advantage, and transport quality advantage and to be at least as good in the remaining two. How were these performance problems solved in the case companies?

7.1 Cost advantage

7.1.1 Empirical observations

In the Volvo case, the economies of scale derive mainly from the size of the volume of own freight the company has managed to reserve for the system. In practice this means consolidating flows from different suppliers in Germany to fill up a train. However, the majority of Volvo's material flow moves in the south-north direction between central Europe and Sweden. The economies of balance in the system leave something to be desired. In order to improve the economies of balance, Volvo has made the system commercially open in the south-bound direction for two road carriers that provide pre- and post-carriage. They are allowed to use empty system capacity for their own customers. Since these carriers belong to the system, the degree of technological openness of the system is restricted to serving Volvo requirements. In addition, choice of ITUs was also made based on cost considerations. As the cargo carried is low density cargo (volume cargo), mega-trailers were considered to be the optimal choice. In the planning process, the requirements regarding cost for the new solution was set as 'slightly lower or equal to current transport cost'. This means that Volvo was not expecting an immediate cost advantage.

In the Stora Enso case, economies of scale are gained through the large volume of freight the company ships in the south-bound direction. Consolidation of large shipment volumes has been possible due to the nature of the continuous manufacturing and distribution processes in which most of the products are produced and shipped based on demand forecasts. Therefore the supply chain is not sensitive to minor regularity disturbances in the transport chain, since regularity variations can be absorbed by buffer stocks at transhipment points between train and ship. Moreover, these buffer stocks enable Stora Enso to realise maximum utilisation of transport equipment. However, company freight flows in the north-bound direction are low in comparison. In order to improve the economies of balance, Stora Enso has opened the system commercially in the north-bound sea link by selling empty vessel capacity in partnership with their vessel operator Cobelfret. Another contribution to cost efficiency by deploying economies of scale is the innovative development of the specially designed 'jumbo' container, the SECU unit. This new unit allowed increased load factors of weight and volume on rail wagons and vessels. This is an important technological and commercial innovation, since it required a unique long term PPP solution in which the Swedish Rail Administration (BV) invested in an increase of the railway profile allowing use of SECU units on two railway links. In exchange, Stora Enso guaranteed long term use of these links paying infrastructure fees to compensate BV for their investment.

The Coop system covers only domestic flows in Sweden. The large inbound flow to the warehouses in middle Sweden originates from producers and importers in the south of Sweden. Points of origin and destination are located within limited geographical areas with sufficient transport distance between them for providing economies of distance. Economies of scale are created by the availability of sufficient total flow volume and the utilisation of maximum load capacity of trains and trailers. Economies of balance are created by reversing part of the consolidated and homogeneous inbound flows from suppliers in southern Sweden to warehouses in middle Sweden into outbound flows of deconsolidated heterogeneous shipments from these warehouses to stores in southern Sweden (together with other flows from a few suppliers in the middle and north of Sweden). To achieve this concentration of flows, Coop's distribution network was restructured during the development process of the new intermodal solution. The new structure included fewer national warehouses located in the vicinity of each other, in combination with an increased number of cross-docking facilities.

7.1.2 Conceptual representation

Conceptually speaking, cost advantage is created by utilising economies of scale and economies of balance. Economies of scale are attained by the size of the freight flows that the case companies manage to mobilise within their own supply chains and move through the systems and also by the use of ITUs, vehicles, and vessels that are chosen to support economies of scale by permitting high load factors. It is interesting to note that high load factors were made possible by increasing the railway profile on links in Sweden used by the Stora Enso chains. Commercial openness improves the economies of balance in the chains of two of the case companies. Main hauls extend over sufficient distances for the systems of the case companies to show economies of distance as well.

7.2 Transport quality advantage

7.2.1 Empirical observations

In the Volvo case, transit time and regularity are crucial quality dimensions. The assembly operations in Volvo factories are sensitive to long and uncertain lead times. This need of stable freight flows has influenced both the choice of system partners and the length of contracts. The expected long term commitment of partners was an important criterion in system design. DB was chosen as the main train operator since it was assumed to have sufficient power and control to minimise delays and interruptions (enabling access to German Automotive Rail Net[3]). A contingency system was developed by Volvo to be used in case of unexpected delays or interruptions in the railway part of the intermodal chain. The contingency system has three alternatives: road only, different train routes, and combined road/sea solutions. When developing the contingency system, the choice of ILU took into account the ability to switch to road in case the need occurs. The design of this solution stresses the importance of regularity of flows for Volvo since the transport solution is part of the manufacturing process. Moreover, improved response to disturbances was achieved through developing a quality handbook and establishing informal contacts with sub-suppliers of services.

Stora Enso's products, mainly paper reels, but also some palletised paper, are sensitive to damage from physical handling and weather conditions. Therefore, goods comfort is a vital quality dimension. The SECU jumbo container protects the cargo very well in addition to other advantages it possesses. Transit time and regularity do not have the same significance in the Stora Enso case, since buffer stocks in the distribution system of this process industry can absorb effects of variations in transit time. A contingency solution based on wagon load railway transport has been prepared.

Coop is the second largest grocery retailer in Sweden. The product flow moved in their supply chain is entirely domestic and finally aimed for Swedish retail stores. It consists of inbound flows from suppliers, mainly in southern Sweden, to central warehouses in middle Sweden and outbound flows from central warehouses to stores in all of Sweden. Time is a vital quality dimension in the Coop case, particularly regularity in the schedules for deliveries to stores. Trucking, using the same ITUs (trailers), can be used as a contingency alternative. Due to sensitivity, the initial cargo composition was revised and fruits were removed from the intermodal solution.

7.2.2 Conceptual representation

It is interesting to note that the case companies prioritise quality dimensions differently. For supply to assembly operations such as to the Volvo factories, regularity is a prime quality dimension, given reasonable transit times. The same goes for distribution to retail stores where regularity, given reasonable transit time, is a vital dimension in order to get products on the retail shelves in time. This is not the case with intermodal chains which are integrated in distribution systems with stocks. Here the impact of variations in lead times can be absorbed by buffer stocks such as in the Stora Enso case. For Stora Enso, goods comfort is the most important quality dimension due to the characteristics of the company's products.

7.3 Environmental advantage

There does not seem to be any explicit design effort made by the case companies to maximise environmental advantage when they develop their own intermodal solutions. The environmental objectives are expected to be fulfilled by the change to intermodality as such. However, design impacts are not as absent as they may seem to be. Environmental advantage will be associated with economies of scale and economies of balance of the system. If economies of scale and balance are maximised by design, then the system is very likely to become environmentally more efficient since the environmental impact is positively associated with the use of energy. Further increase of environmental efficiency by technical solutions would reduce cost efficiency given present technologies.

8 What are the main characteristics of shippers developing CUMITS?

The case studies show that shippers, who have decided to develop and manage their own intermodal transport solutions, possess two basic characteristics normally considered necessary for the implementation of any intermodal system: *large and concentrated flows*, and *sufficient distances from origins to destinations*:

- Stora Enso: Sweden/Finland – Belgium
- Volvo: Sweden – Germany
- Coop: South-West of Sweden – Central-Eastern part of Sweden (approximately 600 km)

Moreover, in line with the traditional view on intermodal transport as being less environmentally damaging compared with road transport, in all three cases environmental reasoning was important. Generally, continued use of road transport has more and more become a problematic strategic threat against many companies' *environmental goals* and long term competitiveness. At the same time, shifts to intermodal solutions are increasingly being considered as an opportunity for reducing the strategic threats as shown in this study.

In all three cases, efficient and effective transport is a major factor for overall competitiveness:

- Coop: The competitive pressure in the grocery retail industry is high, leading to low product margins. The spatial extension of Coop's retail outlets makes transportation costs a relatively high share of total landed product cost. The combination of these two factors make efficient and effective transport important.
- Volvo: The assembly plant has a peripheral location in relation to major suppliers. Transport being a part of a complicated logistics flow must fulfil very rigid service requirements since the whole system is vulnerable to disturbances. Transport quality is a main concern.
- Stora Enso: The paper mills are located peripherally in Scandinavia far from main customer markets and competing with more centrally located competitors. The product has high requirements on goods comfort. This makes efficient and effective transport important in this process industry with large volumes.

In addition, all three case companies are *major and powerful buyers in the transport market having financial and other resources* and therefore attractive to cooperate with for other actors in the transportation industry. For instance, when Coop took power over transport in the supply chain they were able to invest in their own intermodal terminal. In the case of Volvo, being a major buyer in the transport market, made Volvo attractive for hauliers. Finally, in the case of Stora Enso, the Swedish Railway Administration (BV) agreed to invest in an increased railway profile because Stora Enso was such a major transport buyer in the Swedish market, and because Stora Enso had resources to invest in the customised ILUs.

Finally, all three case companies had a positive *experience from using* mainly *rail*, but also to a limited extent *intermodal rail/road transport* previously. Volvo and Coop have been using rail since the 1950s, mainly in conventional wagon load setups. Similarly, Stora Enso had a long experience in using wagon load rail transport. In line with the mode choice literature, existing experience influences transport buyers' attitudes (Floden et al., 2010).

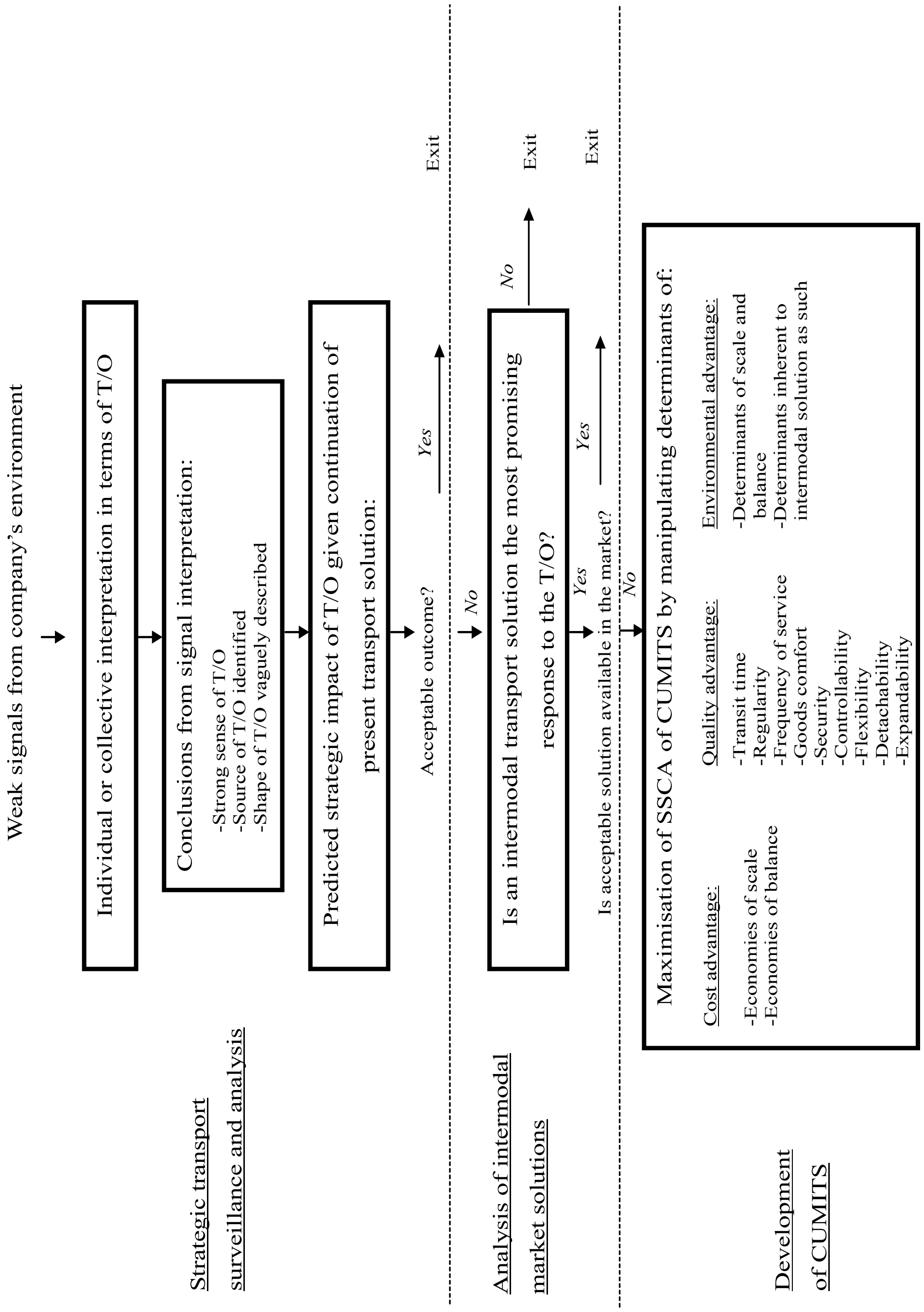
9 A theory of development of CUMITS

We propose a generic conceptual model describing the development of CUMITS. The model is shown in Figure 1. It represents the main empirical observations related to 'why' and 'how' in terms of both our initial conceptual framework and theory connections reflecting our empirical discoveries.

The model represents a development process where the output is either a market-based intermodal solution or a customer managed intermodal solution. The model combines both our descriptive and explanative purposes. We have shown that the model is able to represent the development process in three very different companies, from different industries, with different products, and having different logistics supply chains.

The conceptual model seems to have a high degree of generality despite the fact that it has been developed from multiple case studies based on three cases.

Figure 1 Conceptual model of process leading to development of CUMITS



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Notes

1 Initially part of the intermodal solution.

2 Currently, due to internal restructuring of the organisation the unit as a separate entity is disappearing.

3 Rail-related logistics solutions with a special emphasis on supply deliveries and inter-plant transport where trains have priority in case of disruptions.

Appendix

Interview guide

In-depth semi-structured interviews have been carried out with staff involved in the development/management of the studied intermodal solutions. The questions used during the interviews covered the following themes: general background information on the company; new intermodal solution and the organisational structure; and incentives and driving forces behind the adoption of the solution. Interview guide has been followed, but the purpose has been to cover all the themes of interest (how; why and for whom) rather than ask exactly the same questions to all interviewees. As in many cases the interviewees preferred to answer in a story format rather than a simple question-answer format.

- What is your company's core business?
- What are the transport needs (inbound/outbound)? Who is responsible for inbound and outbound transportation?
- What sort of logistics and transport related activities/services are done in-house? Why so? What sort of logistics and transport related services are sourced? Why so?
- How do you measure logistics/transport system's performance?
- How do you work with environmental questions?
- Has the implementation of the intermodal solution been influenced by environmental considerations?
- What is company's general experience with intermodal transport?
- Discuss specifics of the transport operation: type of freight; geographical coverage; part of supply chain; size of the flow; approximate pre- and post-haulage distances; load units; balanced of the flow.
- What are the specific service requirements?
- Have there been any actions/initiatives to improve the system (or performance)? Which parties are involved in such initiatives?
- Has the implementation of the intermodal solution brought cost savings?
- What is the utilisation of the current system? How do you work with improving the utilisation of the solution?

- Has there been an environmental evaluation of the intermodal solution compared to an alternative/previous solution? If so, have the results shown significant differences?
- What other effect on logistics system's performance have you experienced? Has the intermodal solution been able to fulfil your transport requirements?
- What do you feel have been the driving forces in implementation of the intermodal solution? How have they changed throughout the process: from initiation to actual implementation?
- Has the intermodal solution been designed to replace an existing solution or is rather a new development to satisfy new demand?
- If it replaced an old solution, what kind of problems did you have with the previous transport solution?
- Why not just buy intermodal service from the market, why involve the company in developing the solution?
- Is using intermodal transport part of company's transport or environmental strategy? Have you set any goals regarding that?
- What have been the expected gains (monetary and non-monetary)?