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Long-distance hauliers' transport mode choices

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Abstract

Intermodal transport has benefits over all-road transport in lower external and internal cost with a resulting large potential but many consider the development of intermodal transport not to be satisfactory. This situation is attributed to that barriers and constraints to intermodal transport exist. In previous research, several levels of decision making have been argued to influence the demand for road transport. But the actual choice between all-road and intermodal transport is often taken by a mode decision making firm. Hauliers are one category of users of intermodal transport, thus a mode decision making firm.

Because of the hauliers' anticipated central role in the mode choice the purpose of the paper is to analyze how a haulier's decision making affects the choice between all-road and intermodal transport. The mode choice is described and analysed as part of strategic, tactical and operational decision making with an input-transformation-output perspective of the haulier. This perspective tries to illustrate the complexity of the mode choice that is often stressed in mode choice literature but more seldom explained. With this model of the context of the mode choice the paper explores how the mode choice is treated at two hauliers.

The basis for the mode choice at the hauliers is largely determined at the strategic level in the decision of what resources to acquire. Time flexible resources are preferred which results in that all-road transport is the chosen alternative over intermodal transport. The paper shows that some resources can be rescheduled for intermodal transport at the tactical level. Rescheduling of resources is not done regularly or in a systematic way. At the operational level all-road resources are filled first which have the effect that intermodal resources are used according to the daily capacity requirements.

Introduction

Road transport causes high external costs, e.g. in form of congestion and air pollution and has had and is expected to have a strong growth (Mantzos et al., 2003; ECMT, 2004). This situation is recognised by many actors not to be sustainable, e.g. by the European Commission. For long-distance transport external costs are generally in favour of intermodal transport over all-road transport (Kreutzberger et al., 2003). This is a reason why the European Commission strongly advocates intermodal transport to create a more sustainable transport system (European Commission, 2001). This political will in support of intermodal transport is financially shown in the programmes PACT and Marco Polo launched to support the start-up of new intermodal transport services. Additionally, the private, or internal, cost of intermodal transport is under certain conditions lower compared with all-road transport (see e.g. Cardebring et al., 1996). Such results have been confirmed in several different contexts, e.g. in Sweden and on international routes (Jensen, 1990; Ricci, 2003). The potential for intermodal transport is consequently considered to be large.

This seemingly positive situation and future for intermodal transport is contrasted by that the development has not been satisfactory (see e.g. Woxenius and Bärthel, 2006) and that several major barriers and constraints to intermodal transport exists (Bithas and Nijkamp, 1997; Vreenken et al., 2005). Hence, in order to make use of the potential, firms involved in intermodal transport are anticipated to encounter barriers and constraints.

Several levels of decision making influence the demand for all-road transport (McKinnon and Woodburn, 1996). As a result the firm deciding between all-road and intermodal transport can be expected to exert direct influence on, but not necessarily full discretion over, this mode choice. A haulier is often contracted not directly by the shipper but rather by a logistics service provider or a forwarder to perform the actual transport operation. The haulier is then the mode deciding firm that chooses between intermodal and all-road transport. Previously some mode choice literature have mainly focused at identifying and ranking factors of importance to the mode decision making firm (Jeffs and Hills, 1990; Evers et al., 1996; Cullinane and Toy, 2000) while some have recognised that the mode choice is a multistage process (Pisharodi, 1991). Decision making is generally considered to include more than just the choice and the decision making is part of a haulier's total business. Hence, to understand the haulier perspective of the mode choice an approach including decision making and the haulier business perspective is required.

The barriers and constraints for intermodal transport are often attributed to financial and infrastructural issues (Bithas and Nijkamp, 1997). Consequently, most research efforts have been directed towards these areas. Organizational issues as lack of appropriate intermodal transport services as well as institutional and bureaucratic barriers are also recognised to influence. However, how the decision making of the haulier, a mode decision making firm, affects their intermodal transport usage has been examined to a lesser extent. Issues of relevance is then to what extent the mode choice is made by the haulier, what influences the mode choice, how the mode choice is dealt with and how the mode choice relates to other aspects of the haulier's operations.

Because of the hauliers' anticipated central role in the mode choice the purpose of the paper is to analyze how a haulier's decision making affects the choice between all-road and intermodal transport.

The structure of the paper is that first a model is developed that aims at describing and analysing the decision making in which the mode choice is embedded. Following this model the used methodological approach will be described. Descriptions of two hauliers' decision making are then given. The developed model is used for analysing the decision making of these hauliers. The results from the studied hauliers and the application of the model will then be discussed and finally conclusions are made.

Hauliers and intermodal transport

This section aims at developing a theoretical model to analyze the decision making by hauliers from a mode choice perspective. For a comprehensive model, mode choice literature is reviewed to establish what is recognised to influence the mode choice. To establish the haulier perspective on the mode choice a general input-transformation-output model is used as well as decision making with associated decision problems in freight transportation. Finally a synthesized model is presented.

Mode choice factors and barriers

In trying to establish factors of importance in mode choices, several denotations and categorizations are used in the literature. Throughout this paper the denotation 'factor' is used. In an analysis of freight route and mode choice literature Cullinane and Toy (2000) identified cost/price/rate, speed, transit time reliability, characteristics of the goods, and service (unspecified) as the most considered factors. These or similar factors appear in most studies of mode choices (Murphy and Hall, 1995; Evers et al., 1996; Tsamboulas and Kapros, 2000) These studies focus at identifying and ranking the factors of importance in the mode choice or the perception of a transport mode and are mainly focused at factors that distinguishes the different transport modes from each other, here this aspect is denoted as transport mode factors.

These factors that describes the transport modes is supplemented by a study by Jeffs and Hills (1990). In trying to explain what influence the mode choice they concluded that the factors customer requirements, product characteristics, company structure/organisation, government, available transport facilities, and decision maker are important. By including factors representing a more comprehensive perspective of the mode choice, Jeffs and Hills show that the mode choice relates to many aspects besides the aspects of the transport mode. Jeffs and Hills factors must be complemented with the transport mode factors, including e.g. cost, speed and transit time reliability.

When asked about intermodal transport some actors emphasise existing barriers and constraints making the mode choice biased towards all-road transport (Bithas and Nijkamp, 1997). In one study, transport operators specified costs, unreliable transport times, quality of service, customer demands, and dependence on other companies as barriers for intermodal transport (Van Schijndel and Dinwoodie, 2000). Another study (Jeffs and Hills, 1990) presented reasons that constrain the mode choice. These were parent company decision, customer requirements, price/budget constraint, urgent deliveries, transport infrastructure, company policy, and production level. Bithas and Nijkamp (1997) grouped barriers into the categories financial, hardware, organizational, software, psychological and meta-variables and found the financial and hardware related barriers to be crucial. Summarizing, many aspects have been shown to influence the mode choice.

Haulier position in the logistic structure

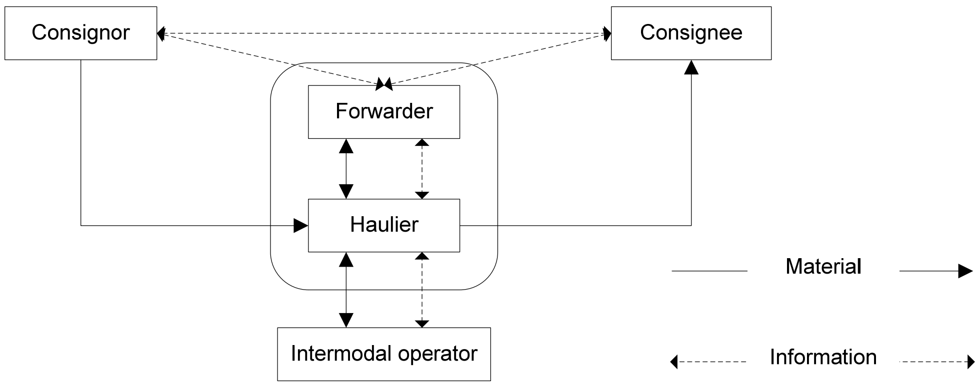

Figure 1 Logistics structure in a forwarder setup, adapted from Stefansson (2004) with the position of the intermodal operator added based on Woxenius and Bärthel (2006).

Other actors have an influence on the transport operations of the haulier. When the haulier is contracted by a forwarder it is primarily the consignor, consignee and the forwarder that affect the haulier from a logistics operational perspective as illustrated in Figure 1. The line around the forwarder and the haulier denotes that these actors operate in a somewhat unified manner as the forwarder holds the customer contact but the haulier performs the transport services. The intermodal operator is contracted by the forwarder or the haulier depending on the present business setup. In intermodal transport at least one intermodal operator is involved. Several public authorities also influence the operations by setting the frames through infrastructure and regulations.

Hauliers' decision making with associated decision problems

Decision making is the process of choosing among alternatives (Greenberg and Baron, 2000). Generally, analytical models of decision making (Rosenfeld and Wilson, 1999; Greenberg and Baron, 2000) follow a structure starting with problem identification ensued by generation and evaluation of alternatives which leads to a choice. The chosen alternative is then implemented and followed up. It is recognised not to be the process followed in actual decision making but taking this kind of process perspective on decision making facilitates a structured description and analysis of decision making (Rosenfeld and Wilson, 1999; Greenberg and Baron, 2000). A transport mode choice is consequently part of a process involving more than the mere choice which is recognised in previous mode choice research (Pisharodi, 1991). To analyse the transport mode choice from the perspective of the mode decision making firm requires that the decision making, which the choice is a part of, is described.

McKinnon and Woodburn (1996) identified that the road freight transport demand was related to four levels of logistical decision making within a manufacturing firm: structure of the logistical system, pattern of sourcing and distribution, scheduling of product flow, and management of transport resources. This means that decisions made by other actors than the haulier have an influence on the demand for a specific transport mode.

Many planning models have been developed to assist decision making in freight transportation (surveys of existing models are given in Crainic and Laporte, 1997; Grünert and Sebastian, 2000; Roy, 2001). By using decision making levels, problems faced by transport operators can be classified and analysed (Crainic and Laporte, 1997; Roy, 2001). These levels are labelled as strategic, tactical, and operational. What distinguishes the levels is how long-term effect decisions at each level have, ranging from long-term through medium-term to short-term. Typical planning problems at each level are given in Table 1.

Table 1 Typical planning problems in a transportation system (Crainic and Laporte, 1997)

Decision level	Decision issue	
Strategic	Physical network design Resource acquisition	Location of main facilities Definition of broad services and tariff policies
Tactical	Service network design Traffic distribution	Terminal policies Empty balancing Crew and motive power scheduling
Operational	Scheduling of services, maintenance activities, crews etc	Routing and dispatching of vehicles and crews Resource allocation

Strategic decisions determine general development policies and broadly shape the operating strategies of the system over relatively long time horizons (Crainic and Laporte, 1997). One such operating strategy is which transport modes to utilize. Over a medium-term horizon, the tactical decisions aim to ensure an efficient and rational allocation of existing resources (Crainic and Laporte, 1997). Allocating transport resources, e.g. trailers, to all-road or intermodal transport over a medium-term horizon belongs to this decision making level. Operational decisions aim to ensure that the demand is satisfied within required service criteria and the resources of the haulier are used efficiently. Decision problems at this level have to consider the time factor and have to deal with that the system is in constant change (Crainic and Laporte, 1997). Transport mode decision factors reveal that the mode choice often relates to the time factor, e.g. transit time, order time, punctuality, timing and frequency (Sommar and Woxenius, 2005). All decision-making levels at a transport operator with a mode choice can thereby be anticipated to directly or indirectly affect the mode choice.

Dividing the transport operations in decision making levels and decision problems is helpful in solving and analyzing separate problems. Basically, however, a transport operation is a process. A process transforms an input to an output. Input to a process are either in form of resources to be transformed or transforming resources while there is an environment of indirect influence (Slack et al., 2004). In Slack et al's (2004) basic input-transformation-output model the different parts are defined as follows. Input transformed resources are defined as resources that are treated, transformed or converted in the process. These are e.g. in the form of materials, information and customers. Input transforming resources are resources that act upon the transformed resources. Common such resources are facilities and staff. Transformation processes are the processes that take in a set of input resources which are used to transform something, or transformed themselves into an output of goods or services. Transport companies mainly process materials by that they change the location of materials. Output services should primarily satisfy customer needs.

Putting in Jeffs and Hills' (1990) factors in Slack et al's (2004) input-transformation-output model will clarify the haulier perspective on these factors. Customer requirements and product characteristics are treated and transformed in the process which defines them as input transformed resources. Available transport facilities are used by the decision maker to act upon these transformed resources and are thereby transforming resources. Employed transport facilities operate within certain regulations and utilizes existing infrastructure defining them as transforming resources. Both regulations and infrastructure are characterised by Jeffs and Hills (1990) under the factor 'government'. How the firm decides to structure its operations classifies the factor 'organization' within the transformation process. The 'transport mode factors' relates to how different transport modes performs and is also characterized as input transforming resources.

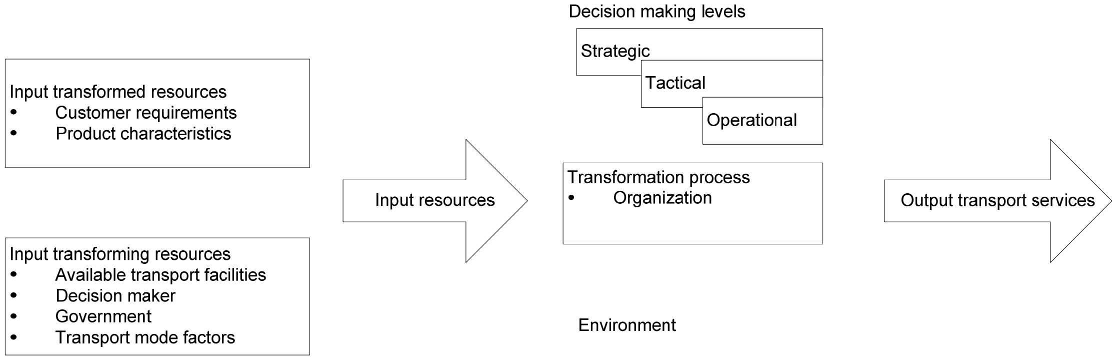

Figure 2 The mode choice context at hauliers using Slack et al's (2004) input-transformation-output model and Crainic and Laporte's (1997) decision making levels of transport operators.

In producing transport services a set of input resources are transformed by available transport facilities to outputs, primarily in the form of transport services. During the transformation process different transport modes are available implying a mode choice. To accomplish this transformation process the haulier faces a number of decision problems, which can be grouped into decision making levels with different time horizons. The synthesized model of the haulier perspective on the mode choice in Figure 2 enables a structured description and analysis of the decision making relating to the mode choice in the dimensions decision making levels and input-transformation-output process. Each decision making level consists of a number of decision problems. Relating the decision problems of the haulier to the input-transformation-output perspective facilitates for a more comprehensive approach to describing the context in which the mode choice is made.

Haulier selection

To analyze the decision making at hauliers, case studies was deemed appropriate. The case studies of selected hauliers facilitate the application of the developed model on the mode choice context at hauliers in Figure 2. As the attempt in the paper is to explore and analyze the decision making at hauliers, two hauliers was considered enough to study. Hauliers with similar circumstances were selected, e.g. transport relations are about the same length, a regular intermodal service is offered and that the hauliers are contracted by the same forwarder in the same country. The reason was that these circumstances then can be anticipated not to have a decisive impact on the mode choice. One important intentional difference though exist between the two selected hauliers, one haulier use intermodal transport and the other is not but has considered it.

Hägerstens Åkeri AB and AB Gustav Perssons Åkeri, two medium sized long-distance hauliers were selected. Their main transport relations was studied, between Gothenburg and Stockholm with a distance of about 470 km, and Malmö and Stockholm with a distance about 610 km respectively. Both are hauling for the forwarder Schenker. On the studied transport relations, intermodal transport services have been offered for several years. The intermodal transport services are for overnight transports. Goods volumes on the studied transport relations of both hauliers are considerable, i.e. several daily trucks are dispatched.

To start to collect the required information from the selected hauliers, interviews were done with the managing director of respective haulier. The flows of the each haulier were then mapped together with a transport planner, and a follow up conducted separately with both the managing director and the transport planner. A brief general introduction to the hauliers follows.

Hägerstens Åkeri AB (HÅ)

Hägerstens Åkeri is responsible for long-distance transport from Gothenburg, Vänersborg and Ulricehamn to Stockholm for Schenker. In this study the transports between Gothenburg and Stockholm have been covered, the major part of the haulier's operations. Between these cities the distance is about 470 km. Owner of the haulier is the two hauliers Arosfrakt AB and TGM AB. HÅ have 50 lorries and semi-trailer tractors, 50 trailers/semi-trailers and about 25 swap bodies with a total yearly turnover of about 100 million SEK and employs 10 administrative staff and about 90 drivers. Their offices in Stockholm as well as in Gothenburg are in the vicinity of the regional Schenker terminal.

AB Gustav Perssons Åkeri (GP)

GP operates the transports for Schenker from Helsingborg, Karlshamn and Stockholm to Malmö as well as some distribution in Skåne and Stockholm. In this study the transport between Malmö and Stockholm have been covered, the major part of the haulier's operations.

Between these cities the distance is about 610 km. Totally GP have 70 lorries plus 50 trailers with a total yearly turnover of 115 million SEK. They employ 125-130 persons and have their own repair shop, car wash and paint shop in Malmö as well as a terminal facility in Stockholm, located west of the city. GP is owned by Bilspedition Transportörer Förvaltnings AB, the association for hauliers contracted by Schenker in Sweden.

Studied hauliers operations and decisions

This section presents the context of the studied hauliers, as well as the decision making of these hauliers. First, the relation between the forwarder and the hauliers is described. The decision making at the studied hauliers is described using the analytical model of decision making.

Forwarder transport services and relation to hauliers

The hauliers are contracted to transport several different consignment types and sizes as the forwarder offer several types of services. All services are for unitized goods, both tempered and non-tempered. Consolidated cargo is for consignments less than 1000 kg including the services parcels and consolidated cargo. The parcel service is much more standardised than the consolidated cargo service. Consignments over 1000 kg can either be truck load (TL) or less than truck load (LTL) depending on if it fills a transport resource or not. The variety in services and consignment sizes calls for terminal to terminal as well as door to door transports by the haulier. The forwarder designs and operates the network while the hauliers are contracted to perform the transport services, thus the forwarder defines the provided transport services but contracts hauliers to perform them. Further, the forwarder offers these services with a full geographic coverage while different hauliers are contracted on specified transport relations. The forwarder has divided Sweden in 24 districts and long-distance hauliers are responsible for transport between two or more of these districts. Table 2 summarizes which mode choice factors the actors influence and their respective role and activities in the studied context.

Table 2 Actor influence over the mode choice factors with their roles and activities

Actor	Influenced mode choice factor	Role/activity
Consignee, consignor	Customer requirements, product characteristics	Requiring transport services for their goods
Forwarder	Available transport facilities, organization & decision maker	Holds customer contract, operates consolidation terminals, responsible for door-to-door transport
Haulier	Available transport facilities, organization & decision maker	Performs hauling from A to B primarily with own transport resources, subcontractor to the forwarder, mode decision-making firm
Intermodal train operator	Available transport facilities, transport mode factors	Provides terminal-to-terminal train and transhipment services for intermodal loading units (ILU), subcontractor to the haulier
Government	Government, transport mode factors	Provides transport infrastructure, sets transport regulations, impose taxes

The haulier mode choice is in the form of choosing between using own fleet for all-road transport or using an existing intermodal terminal-to-terminal service and performing the start and end transport with their own lorries.

Strategic decision making level

The need that HÅ and GP faces at the strategic level is that transport capacity is required, either to replace existing resources or to extend the capacity. Input transformed resources expressed as product characteristics strongly guide the perceived need of specific features of the required transport resource, e.g. tempered, long or heavy goods. Customer requirements in form of timing of delivery are often outside the offered intermodal transport service. All-road transport is flexible regarding departure and arrival times while the intermodal transport services generally are limited to one departure per day. Transport agreements with customers are generally for one to three years whereas the transport unit is expected to roll seven or eight years on the long-distance relation.

The main alternative considered by both HÅ and GP for all-road transport is a lorry with truck body with an attached trailer, a 24 meter vehicle combination. For intermodal transport HÅ has articulated lorries (semi-trailer with tractor), a 18.75 meter vehicle combination. GP considers lorry and trailer with one short (approximately 7.45 meters) and one long (approximately 12 meters) swap body for their future intermodal transports. Intermodal transport adaptation makes the total unloaded vehicle heavier which reduces the loadable weight. With a dolly, HÅ's intermodal semi-trailers can be transported by the lorrys intended for all-road transport. But semi-trailers are not always fully compatible with the lorries, because if a refrigerated semi-trailer is connected to the lorry the vehicle combination becomes too long.

Extra features considered by HÅ are tail lift, removable sides for loading from the long side of the transport unit, fridge or freeze capacity, swap body on the truck, and horizontal bars for double stacking. Some features are not practically compatible, e.g. freeze capacity and removable sides, or not efficient, e.g. tail lift and swap body. GP considers all these extra features except swap body. On the other hand they consider dangerous goods classification.

Both HÅ and GP distinguish between reinvestments and new investments in transport resources. Reinvestments constitute the major share of investments. HÅ and GP faces new investments in case of larger customer contracts that require extended transport capacity. For reinvestments, HÅ generally assumes the same transport mode. The chosen features of reinvestments are matched to the expected characteristics of the transported goods and to the features of the existing transport resources. Both HÅ and GP wants to be able to fulfil any transport request which requires that a suitable transport resource is available, hence an aim for flexible resources. When the preferred extra features of the truck are mutually exclusive the aim is a balance in the whole fleet of trucks. The wear on the trailers in HÅ's traffic is experienced as high and for that reason they prefer premium trailers. Semi-trailers for intermodal transport are considered by HÅ to be relatively cheap.

When a vehicle for all-road transport is bought, both HÅ and GP drop the intermodal transport adaptation option. The reason is that intermodal transport is not expected to be used and GP do not want to limit the loadable weight by the intermodal adaptation. Increasing fuel costs and future road pricing is not influencing the resource acquisition towards intermodal transport adaptation. GP also judge the refrigerating machines to be so unreliable that they need constant supervision making these units unsuitable for intermodal transport. This judgement is not shared by HÅ. Minor features that make the vehicle easier to sell when used some years are chosen by HÅ and the investment cost is not decisive when the vehicle and its extra features are chosen. Both hauliers buy extra, relatively inexpensive features that are expected to be used infrequently but regularly. Both HÅ and GP buy their all-road vehicles while HÅ either buy or rent their intermodal semi-trailers.

The managing director at HÅ and GP respectively is responsible for the investment judgement while the board takes the formal decision. HÅ buys the whole all-road vehicles from the same retailer while GP buys the lorry with chassis and the truck body separately. GP sends one order a year for a number of vehicles and HÅ groups several vehicles in one order to receive a quantity discount.

At HÅ the history of the investments is not recorded systematically whereas GP systematically records and allocates costs to the vehicles. One of the owners of HÅ, another haulier, has a good register over the cost of different vehicles they use that compensates for some of the lack of follow up cost information. Both managing directors use this information for analyses and in the investment judgements.

Tactical decision making level

At the tactical level the transport resources are scheduled to drive on a preset route with some typical stops and arrival or departure times that structures the route on the long-distance that enables steady driver schedules. Steady assignments usually reserves capacity on a specific route. Customer timing, volume, mode specification and frequency requirements set the basic demands that must be fulfilled. Timing that is outside the performance of intermodal transport indirectly specifies all-road transport. From Stockholm 55 % of the daily capacity transported by HÅ has timing demands that the intermodal transport service cannot fulfil, and from Gothenburg the figure is 53 %. For GP the corresponding figures are from Stockholm 77% and from Malmö 39%.

Smaller consignments of less than 1000 kg are generally picked-up and distributed by other hauliers but GP performs this in Stockholm via their own facility. The volume demand for HÅ is unbalanced with an estimated 30% lower demand in one direction. Generally the hauliers experience no requests for intermodal transport. One exception is a customer of HÅ, who requests intermodal transport for two semi-trailers per day from Gothenburg to Stockholm.

Both for HÅ and GP all-road transport is the main alternative and it is not restricted in time from the outset. Intermodal transport has preset and strict departure and arrival times. Further, intermodal transport is confined to be routed via the intermodal transhipment terminal. For HÅ the transport time for intermodal transport is about the same as for all-road transport from Gothenburg and 1 hour longer in the other direction. GP has two to three hours longer transport time by intermodal transport. The studied relations have one intermodal transport departure per day, except for Malmö to Stockholm which has two departures per day. Further, GP thinks that the intermodal operator changes the service times too often so that intermodal transport is not a confident option. The intermodal terminal in Stockholm is just south of the congested area while the Schenker consolidation terminal is in the north. GP and HÅ share the evaluation that all-road transport is the most flexible regarding time and location, and is the most reliable while intermodal transport has the lowest cost.

The setup for the long-distance drivers on all-road transport can either be by point change, i.e. when one driver with vehicle from each city meets somewhere along the way to switch vehicles and the drivers drive back to the origin city, or complete trip, i.e. the same driver drives the vehicle the whole long-distance. In both cases a pilot driver is employed during daytime for delivery and pick-up of goods. Because the driving time for HÅ is 8 hours between the cities a roundtrip can be performed within 24 hours. GP has at least one and a half hour more transport time on the long-distance which makes a roundtrip within 24 hours difficult.

Point change is the preferred setup for long-distance drivers as the complete trip option implies allowance for expenses for the drivers when they are away from the home city. On the other hand the point change setup requires timely departure of vehicles from both cities which makes them inflexible regarding departure and arrival time but also sensitive to disturbances.

For pick-up and distribution HÅ can utilize an associated haulier for which swap bodies are used for easy transhipment between vehicles. This is a solution used when a vehicle is not capable of performing it on its own because of limited available time. Further, in each city, HÅ has two 17 meter semi-trailers designated for consolidated cargo and these are towed during the night by the semi-trailer tractors by road between the consolidation terminals in respective city. These tractors are used for the intermodal semi-trailers during the day.

Regular consignments are always transported by the same mode and on the same route by HÅ. They have 15 departures every day by all-road while 4 are by intermodal transport. They often allocate part of the capacity on a specific route to consignments with timing demands outside the intermodal service. The rest of the capacity is then also required to go by all-road transport. GP also assign regular consignments to the same route but have timing demands for the whole capacity of a route to a greater extent. They have 12 departures every day, with a seasonal variation from 10 to 14 departures per day. For a detailed description of both hauliers' routes with departure and arrival times, and typical consignment sizes see Appendix I – The hauliers' transport routes. Point changes are done at predefined points by both HÅ and GP. Currently, HÅ and GP route all vehicles scheduled to carry LTL consignments that are booked the same day via the terminal facilities in respective city. HÅ plan to relocate at least one route to drive directly to the south of Stockholm to avoid driving through the congested areas thus saving time. GP have their facility closer to the city but tries to dispatch their vehicles early in the morning to avoid the congestion.

HÅ have no computer, or manual, system support for route follow-up. This makes it hard to assess the appropriateness and profitability of existing routes and possible new solutions before implementation. Volume resource utilization is calculated out of statistics from the forwarder and information on shipments transported outside the ordinary system. These figures are known not to reflect reality but are used in absence of better data. GP on their hand uses an information system for all the transported consignments. They update booking information when it is wrong to be able to use the information in later follow ups, e.g. in resource utilization calculations. However, the system is not used for more advanced tasks, e.g. suggesting routes.

Operational decision making level

At the operational level not already assigned consignments is assigned to a suitable vehicle. As the volumes vary, even on the steady assignments, the available capacity varies. Customer requirements and product characteristics largely determines the possible transport resource to assign to a consignment. Three transport legs must be planned: pick-up, long-distance and distribution.

As determined at the tactical level the main alternative is lorry with truck body and trailer for all-road transport for HÅ as well as GP. HÅ also have semi-trailers for intermodal transport while GP has no resources adapted for intermodal transport. The all-road vehicles used by HÅ usually have capacity for these non-regular consignments in the truck body while the trailer is filled with steady consignments.

The highest priority for HÅ is to fill the all-road vehicles as these are on a preset driver schedule and that they have to dispatch as many vehicles as they receive every day. Intermodal transport is then a good alternative for daily varying volume demands. The price for empty semi-trailers on the intermodal transport service is lower than for loaded semi-trailers whereas the cost is regarded the same for all-road vehicles whether empty or loaded. One negative aspect of the intermodal transport service is that HÅ experience the restitution for damages from the intermodal operator as troublesome.

The traffic managers at HÅ try to distribute the assignments so the working hours are filled for all the employed pilots and none have to work overtime. Unfortunately for intermodal transport, the required transport capacity is not fully known at the intermodal transport booking deadline. Moreover, HÅ have experienced shortages in the intermodal transport capacity at some occasions.

All the transport legs should be efficient, i.e. minimized traffic work while LTL consignments preferably should stay on the same vehicle for the whole transport to save time and work hours. This sometimes results in conflicting interests, e.g. when two vehicles have consignments destined for the same receiving area. This result in that some consignments are reloaded at the consolidation terminals where it would otherwise not be handled. Consequently, when assigning consignments, pick-up and distribution is ideally simultaneously planned. This planning is made manually at both HÅ and GP, and based on the transport planner's knowledge of the dispatching and receiving districts. Further, both HÅ and GP communicate with the drivers by mobile phones.

When the consignments have been assigned to specific vehicles, HÅ sends load disposition lists from the dispatching district office at the haulier to their receiving office. These lists are created independently from the IT-system used for the communication of consignment information between the forwarder and the haulier. GP sends this information via the IT-system between their offices.

The drivers are responsible to calculate if consignments are correctly described in weight and volume on the consignment note, e.g. bulky according to density or if it is stackable, so that the haulier receives the correct payment. When HÅ and GP receive payments from the forwarder these are compared to the consignment notes to correct irregularities.

Analysis

The decisions made by the haulier are in this section analysed by using the synthesised model in Figure 2 assisted with the decision problems at the strategic, tactical and operational decision making levels in Table 1. The section concludes with a table summarizing the main aspects affecting the mode choice at the studied hauliers.

Strategic decision making level

At the strategic level the haulier's are primarily occupied with decisions about what transport resources to acquire and the mix between different capabilities of their fleet, the choice of process technology. This type of choice can be evaluated from the three perspectives market requirements, operations resource capability and financial (Slack et al., 2004). Market requirements for the hauliers are the factors product characteristics and customer requirements. Neither HÅ nor GP perceive any demand for intermodal transport while many other requirements pose demands on the capabilities of the transport resources. The length of transport contracts are shorter than the investment write-off period which result in that general expected rather than specific product characteristics and customer requirements guides the investments. Consequently, expected explicit demand for intermodal transport is low within the write-off period. An increased demand for intermodal transport is however expected to come gradually.

Operations resource capability evaluations take the starting point in existing resources' capabilities which then is evaluated towards the perceived market requirements to achieve a balance between required capabilities that are mutually exclusive in practice, e.g. freeze capacity and removable sides. Fuel costs and future road pricing have not yet resulted in overweighing a different balance between all-road and intermodal transport resources. Further, both regard the ability to solve most customer requirements as a competitive advantage which can explain that flexibility to create routes freely in time is prioritized over the lower cost of intermodal transport. Consequently, for all-road vehicles, adaptation to intermodal transport is not a capability that is chosen.

Financial evaluation of new transport resources is not primarily focused on lowest cost. One reason for this can be that for HÅ both personnel and fuel costs are higher than fixed costs for transport resources. Transport resource dependability is perceived as crucial making preventive maintenance important. Investment costs for transport resources can therefore be anticipated not to rule out the choice of intermodal adaptation.

Tactical decision making level

According to Crainic and Laporte (1997) the main decisions at the tactical level concerns service network design, traffic distribution, terminal policies, empty balancing, and crew and motive power scheduling. With the division of labour between the studied forwarder and hauliers the three first decision issues is made by the forwarder and the two latter by the haulier. Tactical decisions for the haulier translate into establishing an efficient flow of transport resources on their specific transport relation(s), i.e. creating a transportation plan that deals with the issues empty balancing and crew and motive power scheduling.

Motive power scheduling at the studied hauliers is about creating general schedules for the transport resources. For HÅ this includes both intermodal and all-road transport resources while GP currently only have all-road transport resources. The relatively large share of steady consignments result in that both hauliers schedule these on specific conceptual routes repeated regularly, most often every day. Intermodal transport is not on an equal footing with all-road transport with a difference in transport time from zero to a few hours and a low service frequency. As most of the steady consignments have time requirements that restrict them from using intermodal transport, all-road is the only possible choice for many routes. Some of these routes have only time requirements outside the intermodal transport service in one direction which results in that the route is bound to all-road in both directions to keep the balance of transport resources.

Notably, only one customer has explicitly requested intermodal transport, but it resulted in that HÅ started to use intermodal transport for other customers as well. Both GP and HÅ admit that the routes are not often profoundly re-planned although they both agree that intermodal transport would imply lower costs and that it would be practically possible.

That schedules for transport resources are established allows for schedules to be made for the drivers. For all-road long-distance transport the point change driver schedule is considered the most cost effective alternative with the consequence that it is the most common schedule setup for long-distance drivers. This setup makes the routes somewhat inflexible in the short-term. Routes where the all-road long-distance is driven during the night require two vehicles for the route to be performed every day. To keep the balance of vehicles on these daily routes, all-road transport is required in both directions.

Empty balancing regards how to reposition empty vehicles. This issue is simplified for GP and HÅ in that they are not performing transport in a network of terminals; they only have a few transport relations to balance. While both have more long-distance relations the conceptual routes are limited to traffic on the single relation. However, some routes have consignments that are loaded in other districts along the long-distance to minimize empty hauling. Loading at locations along the long-distance disqualifies intermodal transport by that no suitable service is offered.

Operational decision making level

Meeting customers' requirements and using transport resources efficiently at the operational level implies carrying out and adjusting the transportation plan according to prevailing circumstances. This involves all the operational decision problems in Table 1.

Routing and dispatching of vehicles at the operational level of GP and HÅ does not imply a mode choice as the mode is decided upon in the transportation plan at the tactical level and no intermodal adaptation exist for all-road vehicles. Resource allocation, assigning consignments to a specific vehicle, at HÅ is done so that all-road vehicles are first filled and intermodal semi-trailers secondly. Thereby the intermodal transport usage varies from day to day. GP have extra all-road vehicles available for day-to-day variations. At HÅ resource allocation is also used to level pilot driver working hours.

Crew scheduling is primarily done at the tactical level at both HÅ and GP in order to create stable schedules for the drivers. Short-term changes are then difficult, e.g. cancelling the long-distance driver to use intermodal transport instead. The point change driver setup for all-road vehicles meaning that a vehicle has to be dispatched from both districts implies that none of these transport resources can use intermodal transport.

Table 3 Circumstances and factors affecting the choice between all-road and intermodal transport.

	Input transformed resources	Input transforming resources	Transformation process
Strategic	Intermodal transport generally not requested by customers (HÅ, GP)	Same transport mode assumed for replaced transport resources. (HÅ) Intermodal adaptation of new all-road transport resources is not chosen. (HÅ, GP) Intermodal transport time is to long and frequency to low compared to all-road. (HÅ, GP) Absence of constant supervision of refrigerator machines on the intermodal transport service. (GP) Expected rising fuel cost and road-pricing will largely be passed to transport buyers (HÅ, GP)	The hauliers want to be able to solve all requests, i.e. be flexible, and all-road transport is then the best mode. (HÅ, GP) The production performs well which implies that there is no strong incentive for changes. (GP)
Tactical	Timing demands from customers are to a major extent outside the intermodal transport service. (HÅ, GP) Intermodal transport generally not requested by customers (HÅ, GP)	Frequently changing intermodal transport departure and arrival times. (GP) Intermodal transport time is to long and frequency to low. (HÅ, GP) No transport resources adapted to intermodal transport. (GP) The location of the intermodal transhipment terminal in Stockholm is in the congested area. (HÅ)	Intermodal transport used for varying demand to a large extent. (HÅ) Goods with timing demands that exclude intermodal transport are routed together with goods without such timing demands. (HÅ) Routes generally start/end at the consolidation terminals that lie apart from the intermodal transhipment terminals. (HÅ)
Operational	Varying volume demand. (HÅ)	No transport resources adapted to intermodal transport. (GP) Restitution for damages from the intermodal operator is troublesome. (HÅ) Intermodal capacity is sometimes scarce. (HÅ)	Steady driver schedules and the need to balance all-road vehicles acts in favour of all-road transport. (HÅ) Needed transport capacity not fully known at the booking deadline for the intermodal transport service. (HÅ)

Discussion and conclusions

Both the studied hauliers transport goods that are suitable for intermodal transport from a cost and time requirement perspective but which are currently transported by all-road transport. Thus the mode choice is not all determined by customer requirements and hauliers' decision making affects their intermodal transport share. Hence, hauliers, in the role of a mode decision making firm, can play an influential role in making use of the expected large potential for intermodal transport.

This paper takes the mode decision making firm perspective of the mode choice by describing and analysing the mode choice as part of strategic, tactical and operational decision making with an input-transformation-output perspective of the haulier. This perspective illustrates the complexity of the mode choice that is often stressed in mode choice literature but more seldom explained. With this model of the context of the mode choice the paper explores how the mode choice is treated at two hauliers. The mode choice is largely determined at the strategic level in the resource acquisition.

Describing the decision making in which the mode choice is embedded provides the basis for a contextual and wide analytical perspective on the mode choice. By dividing a haulier’s decision making into levels, it is highlighted that decisions at higher levels set the preconditions to decide to use intermodal transport at lower levels. Treating the mode choice as part of a haulier’s input-transformation-output processes illustrates that the mode choice is affected by many aspects, see Table 3, and that the transport mode is a mean to an end for the haulier, i.e. the end is to produce requested transport services.

Input transformed resources impact the mode choice to a large extent at the strategic and tactical levels and to a limited extent at the operational level. The input transforming resources must match the transformed resources in the transformation process, i.e. available transport facilities and intermodal transport services must match product characteristics and customer requirements. This match of input resources is established at the strategic and tactical levels through resource acquisition and motive power scheduling while transport services are executed at the operational level according to the strategies established at the more long-term levels. Intermodal transport services have a lower performance in several aspects compared to all-road transport which disqualifies intermodal transport in many cases.

All-road transport is the preferred alternative over intermodal transport by both the studied hauliers as a time flexible transformation process is desired and intermodal transport is not time flexible. This desire is manifested in the resource acquisition but is based on demands faced in the motive power scheduling and the resource allocation. All decision making levels consequently interacts and affects the mode choice.

All involved actors have an impact on the mode choice; e.g. customers by their timing requirements, hauliers by making the actual mode choice, government by providing suitable road and rail infrastructure, and the intermodal operator by their transport service times and frequency. Considering that the hauliers studied here are affected to a large extent by their customers in their mode choice but still have a decisional influence over the mode choice it would be interesting to study how the involved actors’ decision making interacts and affects the mode choice.

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Appendix I – The hauliers' transport routes

HÅ

Vehicle length* [meter]	Göteborg to Stockholm			Stockholm to Göteborg		
	Departure	Load	Arrival	Departure	Load	Arrival
24	24:00	LTL in truck body, TL in trailer	06	19:00	TL for several consignees	03:30
24	21	TL	05	11	LTL in truck body, TL for several consignees in trailer	20
24	09	TL 3-5 days/week	17	19	LTL	04
24	19	LTL in truck body, TL in trailer	03	19	LTL in truck body, TL for several consignees in trailer	02
24	19	LTL in truck body, CC in trailer	03	10	TL	15
24	17	Refrigerated LTL and CC of various volumes	01	17	Refrigerated LTL in truck body, refrigerated CC in trailer	01
24	17	Refrigerated LTL and CC of various volumes	01	17	Refrigerated LTL in truck body, refrigerated CC in trailer	01
24	07	Frozen CC in truck body, refrigerated TL in trailer	15	19	TL refrigerated	02
24	19	TL	02	06	TL	14
24	19	TL	02	04	TL	14
24	18	LTL in truck body, CC in trailer	01	17	LTL	24
24	11	TL for numerous consignees	19	21	Long goods in truck body, CC in trailer	04
24	19	LTL	04	17	TL for several consignees	24
18.75	19	CC	02	19	CC	02
18.75	20:30	CC	03:30	20:30	CC	03:30
18.75	14	TL	06	15	LTL	06
18.75	14	TL	06		LTL or empty	
18.75	15	LTL or TL	06		Generally empty	
Intermodal transport service	20:45		03:30	20		05

* A lorry with truck body with an attached trailer is 24 meter and a semi-trailer with tractor is 18.75 meter.

GP

Vehicle length [meter]	Malmö to Stockholm			Stockholm to Malmö		
	Departure	Load	Arrival	Departure	Load	Arrival
24	18	Refrigerated TL	04	16	Refrigerated LTL	02
24	18	A few loadings to one consignee	06	20	TL	05
24	18	A few loadings to one consignee	06	20	TL	05
24	21	CC	06	18	TL	04
24	19	LTL	04	15:30	TL in truck body, LTL in trailer	02
24	13	TL	23	07/13	TL to a few consignees some days, other days LTL	23
24	19	LTL	04	19	Two consignors to several consignees	04
24	19	TL to several consignees	04	19:30	LTL in truck body, CC in trailer	04
24	19	CC for both terminals	04	19:30	LTL in truck body, CC in trailer	04
24	19	LTL in truck body, CC in trailer	04	19:30	LTL in truck body, CC in trailer	04
24	19	LTL	04	19	TL	04
24	16	LTL, long goods	02	22	Various LTL, CC and long goods	06
Intermodal transport service	17:40	(departure 1)	03:50	20		05
	21	(departure 2)	06:15			