INTERMODAL TRANSPORTATION FROM A HAULIER'S PERSPECTIVE

AN ANALYSIS ON HOW TO INCREASE THE USAGE OF INTERMODAL ROAD-RAIL TRANSPORTATION FOR HAULIERS IN SWEDEN

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ABSTRACT

Purpose of this paper

The purpose of this paper is to investigate what factors affect the hauliers' modal choice between all-road and intermodal rail road transportation (IRRT). It identifies strategies that can be applied for hauliers to increase the usage of IRRT.

Design/methodology/approach

Based on an empirical study concerning the perspective of the transport industry on role of the hauliers in the IRRT-systems combined with a literature review, an analytical framework for the hauliers' modal choice in Sweden is designed. An interview-study and a survey with hauliers in Sweden currently using IRRT analyse the areas in the analytical framework.

Findings

The findings are presented as obstacles and enablers for increasing the hauliers' usage of IRRT. The main types of obstacles for the usage of IRRT are: lack of profit with IRRT, shippers' requirements not being compatible with the intermodal rail operators' offer and operational difficulties. Depending on what obstacles the hauliers face, enablers like company characteristics and different strategies can be applied to increase the usage of IRRT.

Practical implications (if applicable)

The findings can be used by actors with the incentives to increase the usage of IRRT among hauliers in Sweden.

What is original/value of paper

Most literature on IRRT limits the hauliers' role to be responsible for the pre- and post haulage activities. This paper takes a new perspective focusing on the haulier as the actor who does the modal choice. The originality of this paper is the analytical framework explaining the obstacles and enablers, which have rarely been discussed in the literature before.

Keywords: Intermodal transportation, Intermodal road-rail transportation, hauliers, modal choice, sustainable transport, Sweden.

1. Introduction

Intermodal road-rail transportation (IRRT) combines the cost efficiency and environmental performance of rail with the flexibility of road transport with the objective of enhancing the efficiency of the transport system. The usage of IRRT is, however, limited and rail's modal share of inland freight transport in EU-25 continues to decline, with some exception in specific countries (Eurostat 2008). One common explanation is that shippers generally give IRRT lower marks than road transport, in terms of transport costs, time flexibility and geographical coverage (Bontekoning et al. 2004). The reasons for the slow incline in popularity are well discussed and there are many areas of IRRT where research has been conducted to both improve current solutions and create new ones.

IRRT consists of three main activities; pre and post haulage (PPH) for pick-up and delivery of intermodal loading units, transhipment operations and long-haul rail transport. Despite the relative short distance of PPH in relation to the rail haul, PPH can be responsible for up to 40 % of the total transportation cost (Woxenius and Bärthel 2008), which makes it an important part of IRRT in order to create economical feasible solutions. However, research on PPH and the road haulier's role in the IRRT-systems is limited (Bontekoning et al. 2004). Most research concerning hauliers' activities is focused around optimization of routes and vehicle assignments to reduce variables like rate of empty hauls and trip lengths (Taylor et al. 2002; Wang and Regan 2002; Kelleher et al. 2003; Imai et al. 2007; Caris and Janssens 2009; Santana et al. 2010). Morlok and Spasovic (1994) state that centralizing the hauliers' activities can improve PPH operations and reduce costs. Morlok et al. (1995) look at different strategies which can improve the PPH operations. The strategies include suggestions for both the private and public sector. Centralizing is once more a topic and investments in, for example, smart gates and ITS (Intelligent Transportation systems)-projects are discussed. Niérat (1997) analyses how the market area for intermodal terminals is affected by spatial factors concerning the haulage operations. It is shown that factors as productivity of PPH and the rate of empty hauls in PPH are affecting the market area of an intermodal terminal. Kreutzberger et al. (2006) examine existing intermodal systems in Europe and analyses cost quality ranges for different distances and different haulage operations. In Europe, most PPH operations around inland terminals have a distance of 0-25 km (in one direction), only a few trips exceed a distance of 100km, and the number of terminal visits per day of a truck is 1.4 -2.1.

In sum, the existing research mostly concerns the optimization of routes and performance evaluation and the hauliers are seen as the actors responsible for the PPH-activities but not for the modal choice. In the Swedish IRRT-system, however, it is in many cases the road haulage company which makes the modal choice, i.e. deciding whether to outsource long-distance haulage to rail as an alternative to producing road haulage itself. Sommar (2006) gives one example of this, the usage of intermodal transport in less-than-truckload networks of a Swedish freight forwarder is analysed and it is shown that the hauliers are hired by the forwarder to take care of the door-to-door transportation and hence they are the actors deciding whether to use IRRT or not. To be able to increase the usage of IRRT, it is therefore crucial to understand the customer-group hauliers represent. Hence, the purpose of this article is to broaden the knowledge of how hauliers in Sweden are using IRRT today and to identify possible solutions to increase the usage in the future.

The following section describes the research process chosen for this paper. Section 3 presents the analytical framework for the haulier's modal choice, which is used for the collection of the empirical data. The empirical findings, e.g. how Swedish hauliers use IRRT, are presented

in section 4. Section 5 presents the current obstacles and enablers for the usage of IRRT. The results of this research are discussed in section 6. Conclusions are presented in section 7.

2. Method

Before analysing the hauliers' modal choice, thorough knowledge of the hauliers' role in the Swedish IRRT-systems is required. The starting point of this research is therefore to develop a framework for the analysis of the hauliers' usage of IRRT in Sweden.

The analytical framework is developed based on a literature study and an empirical pre-study. The empirical pre-study analyses the perspectives of the Swedish IRRT actors on the hauliers' role and in this way the important areas for the analytical framework are identified. Semi-structured interviews with in total eight actors were conducted. The actors chosen were three hauliers, one forwarder, two intermodal rail operators, one terminal operator and one lobby organisation. The reason for not only addressing hauliers was that a broader picture was eligible. All interviewees had long experience of hauliers' usage of IRRT and therefore could provide valuable insights for the development of the analytical framework. The pre-study in combination with literature studies on PPH in intermodal transport, is the foundation for the analytical framework, which forms the basis for the collection of the empirical data. The analytical framework is presented in section 3.

Both quantitative and qualitative methods were used for data collection to analyse the hauliers' modal choice in Sweden. First, a survey of hauliers using IRRT in Sweden was conducted. The sample size of the survey was not decided with statistical measurements, due to the reason that the population of possible interviewees is limited. The population consisted of 31 hauliers, which is according to authors' knowledge all hauliers using IRRT in Sweden on a regular basis. A few companies were excluded, which have their own transportation solutions and use IRRT infrequently a few times a year. The whole population was used as sample size. The response rate was 58 % for the survey, which is considered high enough to assure external validity. The results were not analysed with statistical means due to the limited sample. Instead descriptive statistics were used.

For the parts of the analytical framework, where qualitative methods were required an interview study was carried through. Semi-structured interviews were applied, which followed a pre-defined interview guide, but also allowed the interview to be adjusted to the answers given. Yet, the interview guide strongly followed the analytical framework and hence was more structured than the interviews in the pre-study. In total, eight hauliers were interviewed. They were carefully chosen in order to represent different company sizes, geographical position and to cover different company characteristics.

3. Analytical Framework for the hauliers modal choice

In this section, a framework for the hauliers' modal choice will be presented. The framework is based on an analytical process, including input – transformation – output, i.e. input resources are combined in a transformation process resulting in an output which can be either products or services (Slack et al. 2010).

The output of the analytical framework developed for this research is the road haulier's modal choice between all-road and intermodal transportation. The categories that describe the input resources and the transformation process of a haulier are developed here. The first part (section 3.1) defines the company characteristics that are required for hauliers to be able to create efficient and financially viable IRRT operations. The company characteristics can be understood as the input resources of the framework. The second part of the framework

addresses how the hauliers actually perform the decision-making process (section 3.2). From the pre-study, it was understood that hauliers could take an active role in choosing an intermodal strategy and form both their operations and relationships with shippers after that to increase the usage of IRRT. Hence, the second area of the framework is the transformation process.

3.1. Company characteristics

According to Niérat (1997) the following four influencing factors are among the most important for the efficiency of PPH: *the rate of empty hauls*, *the number of operations (Pick-ups/deliveries)*, *goods weight, traffic imbalance and discounts for rail-services* and *the length of the rail – line haul*. Kreutzberger et al. (2006) evaluate how different operations' strategies for hauliers and different distance classes affect the cost of PPH-haulage operations. It is shown that the cost of the PPH depends on how the operations are arranged, the size of flows, arrival and departure times of the rail services and the match of inbound and outbound freight.

These factors identified by Niérat (1997) and Kreutzberger et. al. (2006) in combination with the pre-study are used to develop three categories of company characteristics for hauliers in Sweden using IRRT: *transportation distances*, *haulier's company size* and *transportation volumes*. The effects of these factors on the hauliers' IRRT-volumes are described below.

3.1.1. Transportation distances

Niérat (1997) claims that the transport distance is one of the most important factors. The longer the distance of the transport task, the easier it is for the hauliers to create profitability using IRRT. Based on an analysis for Sweden, Flodén (2007) concludes that intermodal transport is almost always competitive in distances longer than 500 km, can be competitive in distances between 250 and 500 km if the conditions are right, and is not competitive in distances shorter than 250 km. The hauliers in the pre-study expressed the same opinions. It is therefore interesting to see how the length of the IRRT-lines affects the hauliers' use of IRRT.

3.1.2. Haulier's company size

During the pre-study, the importance of the size of the haulier's company was discussed. There were different views upon how large the turnover of a haulier needs to be to be able to create efficient operations. Some actors considered that even hauliers with comparably small turnovers could add value to its company by choosing IRRT while most actors consider that a quite large amount of trucks are required to achieve efficiency for the PPH-activities. Most actors however agreed that the larger a haulier is, the easier it is to use IRRT. The first reason is that the larger a company is, the easier it is to make the required investments that allow the equipment to be used in IRRT. Secondly, it is easier to create efficient operations if the haulier has a larger number of transportation tasks. This is supported by Niérat (1997) who shows that important factors for the competitiveness of intermodal transport are the rate of empty hauls in PPH and the numbers of PPH operations.

3.1.3. Transportation volumes

The turnover of a haulier or the amount of transport tasks alone, however, is not a sufficient criterion for the haulier's possibility to use IRRT. Also, the character of the transport tasks is important. For example, a haulier, who is mainly involved in city-distribution, can have a large turnover, but the possibility to use IRRT is limited since the transport volumes are too small for IRRT. Niérat (1997) indicates that the size and stability of the transport flows are an important factor. Kreutzberger et al. (2006) shows that the cost of the PPH depends on the size of flows, the arrival and departure times and the match of inbound and outbound freight.

In the pre-study, however, the opinions on the importance of large and stable transport flows were divided. One view is that IRRT requires investments that companies do not do in case of unstable and smaller volumes. Hauliers also expressed the opinion that it requires larger and stable flows to gain financially viable solutions with IRRT. There were, on the other hand, also opinions that it is possible to use IRRT for smaller hauliers, using the rail services not more than a few times per month. Hence, since the literature and the pre-study do not provide a clear picture on the importance of stable volumes it is a relevant factor for the framework.

3.2. Decision-making process

The second area of the analytical framework addresses the decision making process. A general way to structure decision-making in a company is to divide the planning decisions into strategic, tactical and operational decision-making levels. Crainic and Laporte (1997) have analysed these levels for freight transportations' planning and operations. The strategic and tactical decision making levels are used in this section to analyse the haulier's transport mode decision making process.

3.2.1. Strategic decisions

On the strategic level, long-term decisions are in focus. For transportation companies it can embrace strategies for large capital investments. It includes decision for design of the physical network and its evolution, the location of main facilities and resource acquisition (Crainic and Laporte 1997).

For the hauliers, decisions on strategic level that will be analysed include decisions for the scope of the IRRT-usage, for example on what transportation routes IRRT services are implemented. These decisions require investments in the vehicle fleet and sometimes also reallocation of operations between different cities. Once implemented, these strategies can be difficult to reverse.

3.2.2. Tactical decisions

On the tactical level, decisions for a medium–term time horizon are in focus. It can include decisions for efficient and rational allocation of existing resources, type of service to operate and traffic routing using the available services (Crainic and Laporte 1997). For hauliers, tactical decisions concern the scheduling of trucks and personnel. It will be further analysed which decisions are applied for choosing IRRT.

4. The hauliers' use of intermodal road-rail transport in Sweden

This section describes how hauliers in Sweden are using IRRT today. The findings of the survey and the interview study with Swedish hauliers are presented according to the areas in the framework, i.e. the hauliers' *company characteristics* and the haulier's *decision-making process*.

4.1. Company characteristics

The three characteristics describing the *company characteristics* are; *transportation distances*, *haulier's company size* and *transportation volumes*.

4.1.1. Transportation distances

The transport distance is here defined as the length of the IRRT-lines. It does not include the individual hauliers' PPH-distances, only the rail haulage distance. On the routes where hauliers use IRRT, the IRRT-volumes as well as all-road volumes were measured. Figure 4-1

shows the IRRT-share for three distances classes, indicating that the use of IRRT increases on longer distances. The IRRT-share for the three groups is: 200-599 km 16 %, 600-999 29 % and 1000-1500 67 %.

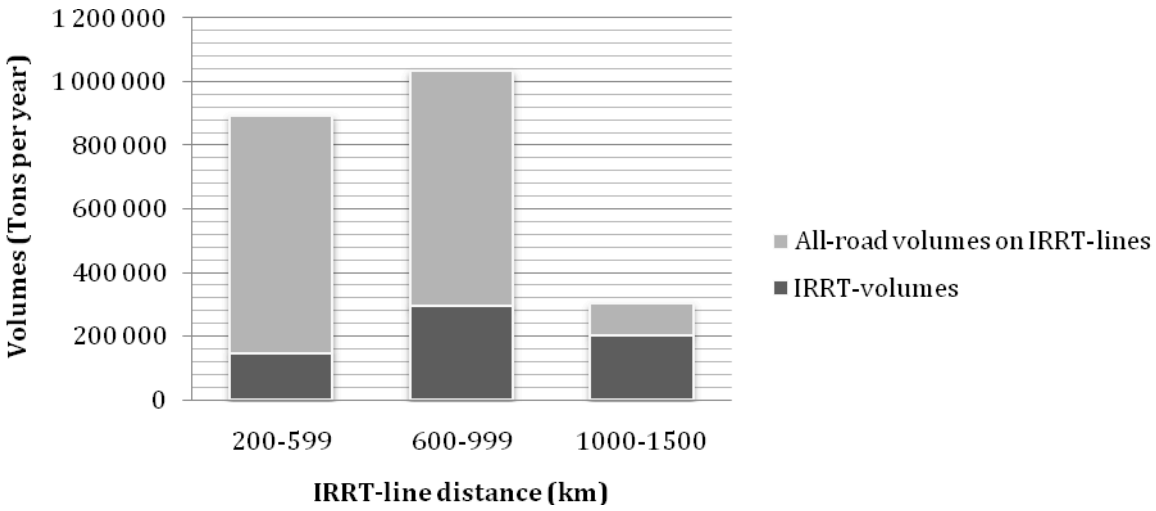

Figure 4-1 IRRT-volumes part of total volumes on IRRT-lines for different distances

4.1.2. Haulier's company size

The average turnover for the sampling frame of hauliers using IRRT in Sweden is 132 million SEK and the median is 78 million SEK. The average turnover of all hauliers in Sweden is roughly 8 million SEK (Åkeriföretag 2008). These numbers show that the turnover of the hauliers who use IRRT are significantly above average which may indicate that it is easier for larger hauliers to use IRRT. However, when analysing the hauliers' usage of IRRT, no relation to their turnover can be seen (Figure 4-2). The results may indicate that hauliers' must have a certain company size to use IRRT but it will not affect their usage in relation to total volumes. Further, the relative volumes on IRRT-lines do not have a correlation with the turnover.

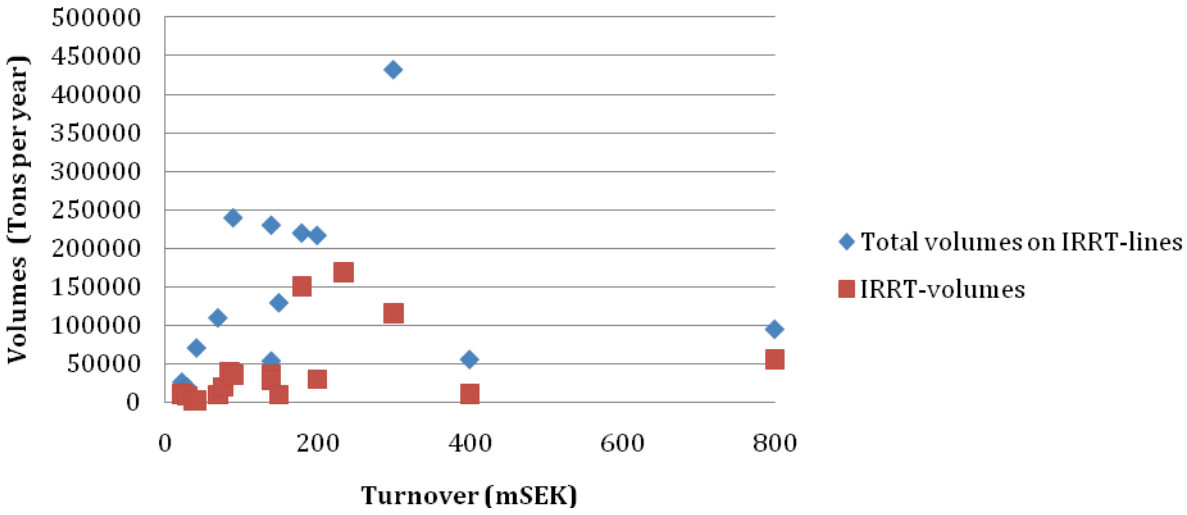

Figure 4-2 IRRT-volumes and total volumes for different hauliers.

4.1.3. Transportation volumes

When analysing the total volumes on IRRT-lines in relation to the usage of IRRT on these lines, no visible trends can be seen either (Figure 4-3). The absolute usage seems to increase with larger volumes, but the relative usage is quite small for the hauliers with large total volumes. The graph though shows that there is a quite large potential for the hauliers currently using IRRT to increase their usage on IRRT-lines.

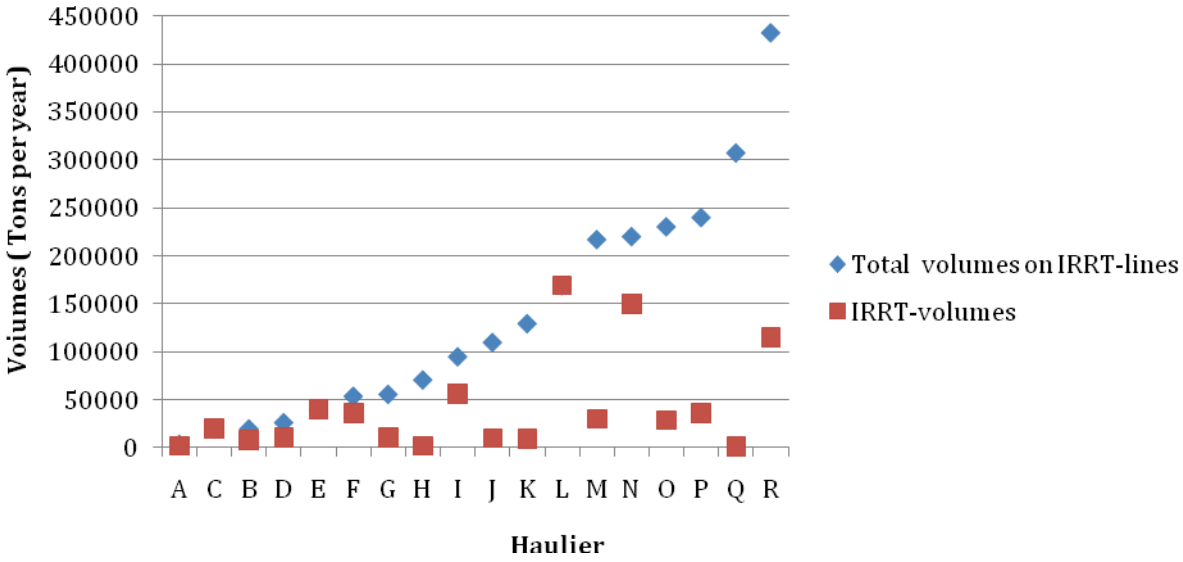

Figure 4-3 IRRT-volumes and total volumes on IRRT-lines for different hauliers.

The analysis of the company characteristics shows that longer transport distances seems to have a positive impact on the usage of IRRT. The company size and transport volumes, however, do not seem to influence the usage of IRRT. It will though be discussed in section 5 how these company characteristics can be enablers for different kinds of obstacles hauliers can face when using IRRT.

4.2. Decision-making process

The hauliers' decision-making process has shown to be important for the usage of IRRT. It will be discussed for the categories: *strategic* and *tactical decisions*.

4.2.1. Strategic decisions

Strategic decisions for hauliers include the investment in transport resources. The first decision on the strategic level is therefore the decision whether trucks and loading units should be purchased which are appropriate for the usage of IRRT or not. Several hauliers have a general goal to increase the usage of IRRT. They consider that environmental aspects will be more important in the future and they therefore aim for a transportation system, which enables the usage IRRT. These hauliers have long-term strategies to use IRRT.

Another strategic reason is the cost advantages that can be gained with IRRT. How hauliers create economical business strategies with IRRT do however vary, both in extent of use as well as in time horizons. First, it is a question of how to handle base-volumes. Some hauliers had a mix of both IRRT and all-road base volumes, others either IRRT or all-road. The second question concerns how to handle the fluctuations in transport volumes, where also all strategies could be applied: IRRT, all-road or mix. An important outcome of these decisions is

the investments that are required to do. Two different strategies were distinguished, which we here name *over-capacity strategy* and *IRRT-strategy*.

Over-capacity strategy

The over-capacity strategy implies that the resources for all-road are kept and only certain amounts of loading units are bought for IRRT. This group of hauliers' use of IRRT is characterized by a relative small share of IRRT in relation to their total transport volumes on certain lines. Their transportation strategy is based on using all-road solutions. The role of IRRT is to handle the peaks in demand, which is commonly known as the "rubber band" strategy. With help of this system they can have a more levelled capacity for the all-road system, which have the advantages of a stable demand for both trucks and staff, facilitating a high utilization rate for the expensive resources. If IRRT is used it is booked on short term with the intermodal rail operator. The whole planning process is done with an all-road system in mind. When asked why these hauliers are not using more IRRT, the answer is usually that it would be too expensive to send larger volumes with IRRT.

The hauliers' want to achieve a high utilization for the all-road trucks and drivers and therefore a stable use for all-road is sought for. Due to the fleet's limited IRRT compatibility rapid increases of IRRT in short perspective are very difficult to achieve.

IRRT-strategy

The other extreme strategy has the opposite perspective on the role of IRRT for the haulier's transport system. These hauliers analyse long-term solutions for goods that can be transported with IRRT. In this strategy the base volumes are transported with IRRT and fluctuations with all-road. Many hauliers have stressed that it is strategic to have a combination of all-road and IRRT, in order to utilize the advantages of both transport modes. Hauliers in this category have pre-booked capacity with the intermodal rail operator, which can range from several loading units per day up to a few per week. Most hauliers that embrace this strategy analyse and change the number of pre-booked loading units a few times per year. They then analyse their upcoming demand and adjust according to their prognosis and changes in shippers demands. Hauliers applying some kind of IRRT-strategy can take the decision that all trucks and loading units shall be applicable for both all-road and IRRT. To motivate these investments a large usage of IRRT must be predicted for the future.

The two types of strategies are shown in Figure 4-4. They represent the extreme cases of how to apply IRRT. The hauliers included in the study apply IRRT in different ways, which could be seen as a mix of the two strategies. Hauliers can also apply different strategies on different lines.

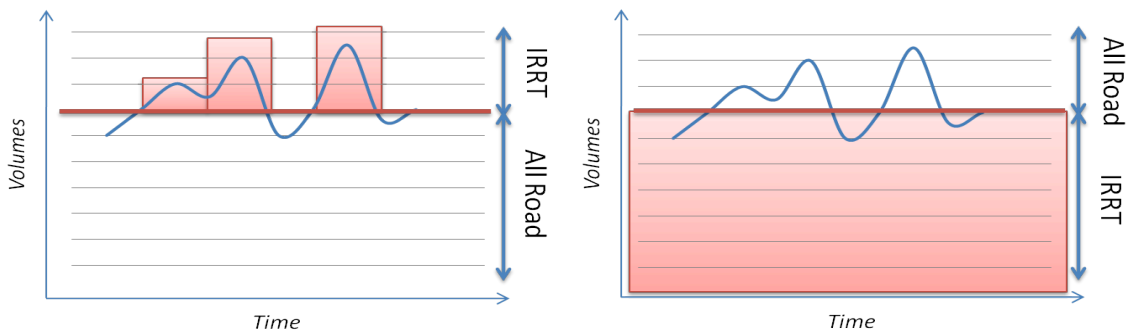

Figure 4-4 Over-capacity strategy and IRRT-strategy

4.2.2. Tactical decisions

For hauliers, tactical decisions concern the scheduling of trucks and personnel. In an IRRT solution this includes creating efficient solutions for the operation of PPH activities. Three different models have been identified in the study. The first one concerns large hauliers having line-haul traffic and operations at both ends of the rail haul. In these cases, the haulage company operates all PPH-activities. It was stressed that the larger amount of operations a haulier has around one terminal, the easier it is to utilize the large-scale benefits.

Small hauliers, who do not have operations at both ends of the rail haul, have to find other solutions for the PPH operations. Some hauliers choose to transport a part of the volumes by truck, which then can also operate the PPH of the IRRT volumes. Another solution is to buy the post haulage service from a different haulier. It can be done either with collaboration agreements or by buying the services from another haulier.

5. Obstacles and Enablers for the usage of IRRT

The previous section shows that a haulier's IRRT usage depends on company characteristics and applied strategies. This section analyses how hauliers create efficient solutions to the obstacles they face to the implementation of IRRT services. The analysis includes the results of both the literature and empirical study. The identified obstacles are *lack of profit*, *shippers´ demand* and *operational difficulties*.

5.1. Lack of profit on IRRT lines

The first kind of obstacle concerns lack of profit on IRRT-lines. All hauliers agree that if the alternative of IRRT is more expensive than the all-road alternative, they would not use it. The company characteristic that seems to have the largest impact on this obstacle is the transport distance. All hauliers with longer IRRT-lines saw the financial incentives with using IRRT. A few hauliers in that group however saw a trend of increasing prices for the rail haulage, which makes the incentives smaller. For many hauliers the main argument for not using IRRT on shorter distances is the lack of profit. Their use of IRRT was comparably low and could be described as the over-capacity strategy. Interestingly, on the same line there are hauliers applying an IRRT-strategy who have a much higher use of IRRT. According to these hauliers other reasons restrict a higher use of IRRT, e.g. the shipper requirements. The differences in use can mainly be explained by the different IRRT-strategies. The hauliers applying an IRRT-strategy, in other words use IRRT for the large base-volumes and the large-scale advantages create profitability. The hauliers with small turnover on IRRT-lines, however, did not claim that they had problems with profitability.

Sommar (2006) discusses the capacity planning in terms of the combination of IRRT and all-road and concludes that hauliers are using an over-capacity strategy, in other words using IRRT to deal with the fluctuations in capacity. There is though no analysis on how the usage can be increased.

5.2. The shippers' demands

The characteristics describing the shippers demands are; *general scepticism* and *time requirements*.

5.2.1. General scepticism

An additional obstacle is the shippers' demands, creating difficulties for the hauliers to increase the use of IRRT. Many hauliers have encountered general concerns from shippers,

when discussing whether an IRRT solution can be implemented for their goods. Shippers sometimes have made negative experiences of using rail or are concerned about the quality levels of the current rail services and therefore generally oppose using IRRT. A few hauliers in the study have tried to address these problems by discussing with the shippers the advantages of IRRT and create solutions fulfilling the demands. The hauliers can discuss the advantages of a certain IRRT service with the shippers. Hauliers sometimes offer the shipper to try an IRRT-solution for a certain period and if it is not working, they can go back to the current transportation solution and use all-road.

However, some hauliers pinpoint that this collaboration also includes a risk for them. If they persuade the shippers to use IRRT but then the service cannot fulfil the shippers' demands due to problems which are beyond the haulier's control, e.g. with the rail infrastructure, there can be negative consequences for the hauliers' relationships with the shippers. In the worst case the haulier may lose this customer affecting the haulier's profitability.

5.2.2. Time requirements

The most specific shipper demand brought up as an obstacle is the time aspect. The shippers' time demands, which in many cases are not compatible with the offer of the intermodal rail operator makes it impossible to use IRRT, especially on shorter distances. On longer transport distances where the time advantage of the truck is reduced this obstacles' relevance is less significant. Some hauliers accept that time in general is an obstacle for IRRT, which cannot be reduced, while some hauliers work actively with decreasing its negative impact. The most common solutions are to engage in discussions with shippers to see if they can change their demands on pickup and drop-off times. The shippers' ability and interest in making adjustments seems to vary. Some hauliers claim that the shippers can in certain aspects accept different pick up and drop off times. For the larger production sites, however, these changes would have consequences that would affect their production and can hence not be changed.

One solution suggested by a haulier, yet not seen in practice, would be to use price-differentiation for the shippers, i.e. offering a lower price if the shippers adjust their demands so it is possible for haulier to use IRRT. Another haulier with a large shipper sending a mix of time sensitive and none time sensitive goods is today sending most goods with all-road because there is a lack of information about the different demands on goods. They currently discuss with the shipper if they can separate the goods, so they can use IRRT for the less time sensitive goods.

This cooperation between shipper and haulier takes time and requires a lot of negotiations. As a consequence, some hauliers indicate that this approach might only be feasible for hauliers with a small number of customers, since they have closer customer relations and a larger possibility to negotiate changes. A lot of the transport volumes which are suitable for IRRT, however, are controlled by forwarders, who consolidate the shipments of a large number of small shippers. In this structure, the hauliers operate the transport services according to time windows agreed between forwarder and shipper and hence have no possibility to separate the goods according to different time-requirements.

Very few hauliers with small volumes on IRRT-lines claimed that they had problems with shipper demands. There are two main explanations for this. The first concerns the type of goods. A few of the small hauliers were specialized in certain kinds of products (for example wet bulk goods), which seems to have less time-demands compared to the larger line-hauliers for example. Secondly, it was stated that the small hauliers' amount of shippers is limited and therefore it is easier to collaborate with them and find solutions suitable for IRRT.

Dobie (2005) suggests that the forwarders shall choose the shippers that fit their strategies, which is one solution to overcome the problems with shipper demands not compatible with intermodal rail operators offers. No hauliers are today either doing this or considering it. It can however be a business strategy to only ship goods on IRRT-lines and with that be able to offer both environmental and cheap transportation services. This would not be interesting for many shippers, but maybe enough to find a new innovative strategy for some hauliers. It is however not a solution for changing the shippers' requirements.

5.3. Operational difficulties

The most limiting factor concerning operational difficulties is the lack of flexibility of IRRT. With IRRT it is not possible to make stops along the route for serving additional shippers in order to increase the fill rate in case the volumes are too small to fill the loading unit. Hence, large volumes on these transport relations are a necessity in order to use IRRT. To some extent, the PPH-operations' efficiency is also improved if the hauliers have more operations around the terminal.

The operational problems are mainly an obstacle for the small hauliers in the study. A few small hauliers collaborate with other hauliers who can perform the PPH-operations in areas where they have no business themselves. One haulier in the study, for example, belongs to a network of removal firms that want to increase the use of IRRT. These companies are quite small and their businesses are situated in one regional area. They have therefore agreed on prices for assisting each other with PPH-activities. With help of this network, if an IRRT-line exists, the companies can buy services according to pre-discussed routines and prices.

Eriksson and Rosenberg (2009) have investigated how collaborations between hauliers in Sweden can take form. Their result shows what hauliers shall consider when starting collaborations. Dobie (2005) and Holguín-Veras et al. (2009) address the problems with volume-sizes. Applying their solutions to the hauliers using IRRT in Sweden, it can be described best that hauliers shall discuss shipment sizes and frequency with their shippers. For example, it can be related to time-sensitivity. Less time sensitive goods can be coordinated over a longer time period with other non time-sensitive goods to achieve shipment sizes which are suitable for IRRT. Another more drastic solution is that the shippers re-arrange their shipment sizes to fit the IRRT-strategies.

Table 5-1 summarizes the different obstacles and the different enablers from both the empirical data and literature.

Obstacles	**Enablers (Empirical)**		**Enablers (Literature)**
	Company characteristics	*Strategies*	
Lack of profit	Long Distances	IRRT-strategy	• Identify the factors making IRRT profitable (Niérat 1997; Kreutzberger et al. 2006) • Capacity mix between all-road and IRRT (Sommar 2006)
Shippers' Demand • *General scepticism against IRRT* • *Time requirements*	Long Distances	Collaboration shippers • *Discussion about the rail-operators' quality* • *Adjustments of time demands* • *Separate time-sensitive goods*	• Plan volumes with shippers (Dobie 2005)
Operations' difficulties • *Stops are required along the route*	Large Volumes/ Large companies	Collaboration with other hauliers	• Plan volumes with shippers (Dobie 2005; Holguín-Veras et al. 2009) • Collaboration with other hauliers (Eriksson and Rosenberg 2009)

Table 5-1 Obstacles and enablers for hauliers' usage of IRRT

6. Discussion

Increasing the use of IRRT among hauliers in Sweden can be achieved in more than one way. Different strategies can be applied depending on the obstacles that limit their use of IRRT. The obstacles that limit the use of IRRT are different for small and large hauliers and therefore different solutions need to be applied. The small hauliers' largest problems concern operational difficulties. Solutions discussed concern collaborations and a larger extent of volume-planning with the shippers to minimize the required stops along the way. To encourage these kinds of collaborations, the actors involved must see the benefits of the required changes in terms of closer collaborations. One concrete solution could be to give some relevant examples of success stories for existing collaborations. It can include both collaborations between a shipper and a haulier as well as between several hauliers. The hauliers in the study with these kinds of collaborations had all taken initiative and created innovative solutions. Actors or organisations who want to increase the usage of IRRT can support hauliers in similar situations to address these strategies and help them see new solutions to encourage a modal shift.

For the large hauliers, the problems are more focused on lack of profits as well as shipper demands. Solutions comprehend internal adjustments as applying an IRRT-strategy and external adjustments as collaboration with shippers. Concerning the profit obstacles, one solution is the suggested IRRT-strategy. To change to an IRRT-strategy and forming a production system of a suitable mix of IRRT and all-road is something a haulier can do independently of other actors. As suggested for the smaller hauliers, they can be motivated by other hauliers' experiences.

To overcome the obstacles concerning shipper demands other actors' involvement are required. One solution is that the shippers change their requirements to adjust to the intermodal rail system. The opposite solution is that the intermodal rail operator improves their offers so it fulfils the shippers' requirements. This research indicates that there must be a solution in between. Shippers have to adjust their demands as well as the intermodal rail operators have to improve the quality of their services. The hauliers, who are the actors in between shipper and intermodal operator, can have an important role to discuss adjustments at both fronts. They can also to a certain extent find solutions for the compatibility problems between shippers' requirements and the intermodal rail operators' offer by having a suitable mix of IRRT and all-road.

For a haulier, there are certain company characteristics improving the ability to use IRRT. Furthermore, the compatibility of the shippers' requirements and the train operators' offer concerning the decision factors influences the possibilities for IRRT. There must however, also be "glue", combining these different parts and integrating them with the hauliers' company strategy. Without an actor seeing the opportunities with new strategies as including IRRT in their operation to enhance cost efficiencies, creating more flexible transport operations or creating more sustainable solutions as a competitive advantage a modal shift from road to rail will never occur.

Hauliers both working with external and internal improvements have large possibilities to increase their total use of IRRT. To find the suitable mix of IRRT and all-road and at the same time to try to improve the external factors is understood to be a successful strategy.

7. Conclusion and further research

Most literature on IRRT limits the hauliers' role to be responsible for the pre- and post haulage activities. This paper takes a new perspective focusing on the haulier as the actor who does the modal choice between all-road transport and IRRT. The analytical framework for the haulier's modal choice explains the obstacles and enablers, which have rarely been discussed in the literature before.

The analysis of the hauliers using IRRT in Sweden shows that the usage depends on company characteristics and applied strategies. The identified obstacles to the usage of IRRT are lack of profit, operational difficulties and the shippers' time requirements. The solutions applied for overcoming these obstacles are an IRRT-based transport planning for creating profitable IRRT services and collaboration with other hauliers to overcome operational difficulties. Shippers have to adjust their time requirements as well as the intermodal rail operators have to improve the quality of their services. The hauliers, who are the actors in between shipper and intermodal operator, can have an important role to discuss adjustments at both fronts.

For further research, it would be interesting to analyse the hauliers that currently do not use IRRT. Obstacles limiting their use of IRRT were beyond the scope of this study. It can be assumed that they have the same restrictions as the hauliers currently using IRRT, but probably there are more obstacles, which were not addressed in this article. A large problem could be that hauliers have a general scepticism against IRRT, which prevents them from finding new solutions including IRRT.

References

Bontekoning, Y. M., et al. (2004). "Is a new applied transportation research field emerging?--A review of intermodal rail-truck freight transport literature." Transportation Research Part A: Policy and Practice **38**(1): 1-34.

Caris, A. and G. K. Janssens (2009). "A local search heuristic for the pre- and end-haulage of intermodal container terminals." Computers & Operations Research **36**(10): 2763-2772.

Crainic, T. G. and G. Laporte (1997). "Planning models for freight transportation." European Journal of Operational Research **97**(3): 409-438.

Dobie, K. (2005). "The core shipper concept: a proactive strategy for motor freight carriers." Transportation Journal **44**(2): 37-53.

Eriksson, B. and P. Rosenberg (2009). Collaboration regarding intermodal transport between regional transport companies - A study of five regional transport companies. Institutionen för teknikens ekonomi och organisation, Logistik och transpo. Gothenburg, Chalmers tekniska högskola. **Master thesis**.

Eurostat (2008). Energy & transport in figures. Brussels.

Flodén, J. (2007). Modelling intermodal freight transport - The potential of combined transport in Sweden. Gothenburg, Logistics and Transport Economics, Department of Business Administration, Göteborg University.

Holguín-Veras, J., et al. (2009). "An Experimental Economics Investigation of Shipper-carrier Interactions in the Choice of Mode and Shipment Size in Freight Transport." Networks and Spatial Economics: 1-24.

Imai, A., et al. (2007). "A Lagrangian relaxation-based heuristic for the vehicle routing with full container load." European Journal of Operational Research **176**(1): 87-105.

Kelleher, G., et al. (2003). "Scheduling for intermodal transport." Logistics Information Management **16**(5): 363 - 372.

Kreutzberger, E., et al. (2006). Evaluation of pre- and post-haulage in intermodal freight networks. Towards better performing transport networks. B. Jourguin, P. Rietveld and K. Westin. London, Routledge**:** 256-284.

Morlok, E. K., et al. (1995). Improving Productivity in Intermodal Rail-Truck Transportation. The service productivity and quality challenge. P. T. Harker. Dordrecht, Kluwer Academic Publishers**:** 407-434.

Morlok, E. K. and L. N. Spasovic (1994). "Redesigning rail-truck intermodal drayage operations for enhanced service and cost performance." Journal of the Transportation Research Forum **34**(1): 16-31.

Niérat, P. (1997). "Market area of rail-truck terminals: Pertinence of the spatial theory." Transportation Research Part A: Policy and Practice **31**(2): 109-127.

Santana, A., et al. (2010). Knowledge of real time position of vehicles and its impact on the improvement of intermodal drayage operations. 12th WCTR. Lisbon, Portugal.

Slack, N., et al. (2010). Operations Management, Financial Times/Prentice Hall.

Sommar, R. (2006). Intermodal transport in less-than-truckload networks, Licentiate thesis, Report.

Taylor, G. D., et al. (2002). "An analysis of intermodal ramp selection methods." Transportation Research Part E: Logistics and Transportation Review **38**(2): 117-134.

Wang, X. and A. C. Regan (2002). "Local truckload pickup and delivery with hard time window constraints." Transportation Research Part B: Methodological **36**(2): 97-112.

Woxenius, J. and F. Bärthel (2008). Intermodal road-rail transport in the European Union. The future of intermodal transport. H. Priemus, P. Nijkamp and R. Konings. Cheltenham, UK, Edward Elgar**:** 13-33.

Åkeriföretag (2008). Fakta om åkerinäringen. Sveriges Åkeriföretag. S. Åkeriföretag. Danderyd.