

CHALLENGES IN INTERMODAL LOGISTICS NETWORKS AND TERMINALS

- A NORWEGIAN VIEWPOINT

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ABSTRACT

Based on case studies in Norwegian transport industry, this paper identifies challenges for intermodal logistics networks and terminals. In order to make intermodal transportation a success, the transport chain must have seamless interconnectivity between the transportation modes. Today's intermodality in Norway is far from seamless. By reducing transaction costs at the transfer points, the terminals can ensure seamless interconnectivity and improve efficiency in the transportation chain. Findings from the case studies identified the following main challenges: (1) Improving cooperation between the actors in the intermodal logistics network, (2) Improving communication of train and freight information to customers regarding arrival, loading/unloading window and deviations from plan, (3) Improving IT-system interconnectivity and information sharing in general, (4) Improving the efficiency of terminal operations in general, (5) Developing cooperative depot management, and finally (6) Automation of manual check points in the material flow.

Keywords: intermodal freight transport, logistics networks, terminals, challenges

INTRODUCTION

Due to the global competition in logistics services and the focus on environmentally friendly transport, intermodal transportation is achieving increasing attention (Netland and Spjelkavik, 2009). The European Union has put Transport as one of its strategic fields of interest. It is clearly communicated in their transport policy that intermodal transport is a favored alternative to road transport. Rail transport is one of the focal points in the EU strategy. The aim is to extend the intermodal network in Europe and to remove barriers for using intermodal transport (van Klink and van den Berg, 1998, Woxenius and Bärthel, 2008).

The European Commission (2009) states that:

“The optimal functioning of the transport system requires full integration and interoperability of the individual parts of the network, as well as interconnection between different (modal) networks. Crucial in achieving this result are the nodes, which are the logistics centers of the network and offer connectivity and choice for both freight and passenger transport. Intermodal and transshipment platforms should be promoted and developed where there is a potential for consolidation and optimization of passenger and freight flows. This will typically be the case in areas with a high activity of passengers and freight transport, i.e. in urban areas, and where high-volume corridors are intersecting.”

The terminal is the key to achieve competitiveness in intermodal networks. Figure 1 shows the terminal's importance in achieving an efficient intermodal freight transport. Present intermodal transportation is far from seamless, and reducing transaction time and costs at the transfer points will be of the most important issues to address today (Chatterjee and Lakshmanan, 2008), building coherence between the transportation modes. It is at the terminal that the “*inter*”-aspect of intermodality is realized (Netland and Spjelkavik, 2009). A mutual initiative across competitors' and industrial boundaries is required to realize the potential that lies in increased intermodality. The purpose of this paper is to present industrial challenges experienced in Norwegian intermodal logistics networks and terminals, which currently impedes a mutual initiative and cooperation towards an efficient intermodal logistics network in Norway.

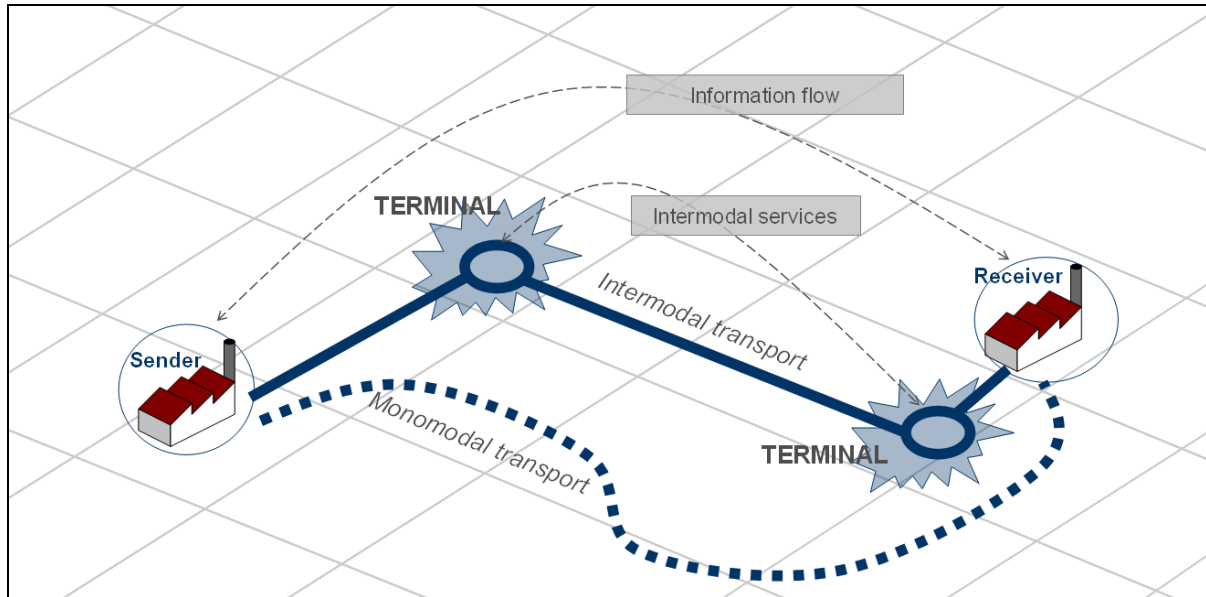


Figure 1 - The terminal is the key to achieve competitiveness in intermodal networks

An overall political vision is to transfer more cargo transport from road to rail and sea, by developing an efficient and profitable intermodal logistics network. The Norwegian National Transportation plan 2010-2019 stress that the Port of Oslo and the Alnabru terminal will play essential roles for intermodality in Norway in the coming years (NTP, 2009). The research project PROFIT (Project Future Intermodal Terminals) aims to address this call for attention from the government.

PROFIT is partly sponsored by The Research Council of Norway through SMARTRANS – a research program for industry transport and intelligent transport systems. The project started in 2009 and concludes by the end of 2011. By changing the terminal layout and control systems at both the Port of Oslo and the Alnabru terminal PROFIT aims to generate profit for the entire supply chain (PROFIT, 2010). The project includes major actors in the Norwegian transport industry: CargoNet (freight train operator and terminal operator), Jernbaneverket (the Norwegian National Rail Administration and rail infrastructure owner), DB Schenker (international freight forwarder), Bring Logistics (international freight forwarder), LTL (Norwegian forwarding association), Ergo Group (IT provider) and the Port of Oslo. In accordance with The National Transport Plan (NTP, 2009) PROFIT aims to develop efficient intermodal terminals and network through improved collaboration between ports, carriers, terminals and forwarders.

Collaboration between autonomous companies to solve collective problems is at best challenging, this because of the companies' different aims and ranking of priorities, non compatible software, and unclear guidelines on dividing of profit and risk. The terminal is only a small part of the different companies operating range, but the whole network is depended on an efficient terminal to maximize their competitive ability. The cooperation evolving from PROFIT is in this sense a groundbreaking step forward for Norwegian intermodal logistics providers.

The paper gives a perspective on the state of affairs among intermodal logistics network actors in Norway. An evaluation of the actors' challenges from a holistic network perspective is presented, and the main challenges regarding an effective future intermodal logistics network is explained. The paper paints a picture of the current state of intermodality in Norway, and concludes by presenting a set of recommended actions to address the identified challenges.

INTERMODAL TERMINAL THEORY

Although intermodalism can be interpreted differently from person to person, most definitions involve the integration of two or more modes of transportation when moving passengers or cargo through seamless connections from origin to destination (Goetz and Rodrigue, 1999; OECD, 2002). The transshipment can be between similar modes (i.e. rail-rail, road-road) or between different modes of transport (i.e. rail-road, sea-road). Integration between the transport modes occurs at the terminal. That is why all intermodal logistics must rely on efficient terminal operations. The core of an intermodal logistics network is the intermodal terminal where material flows and logistics providers physically meet and transact.

Due to the impact global competition has had on transportation, Rondinelli and Berry (2000) argue that corporate strategic alliances and global manufacturing networks are among the most important responses. This has given ground to the expansion of intermodal transportation services to connect the components of international corporations' production and distribution systems around the world. In order to serve customers from door to door or factory to door, transport by sea and/or rail must always be combined with road from dispatch location, the last lap to end destination, and through terminals for change of transportation mode. Intermodal transport networks become efficient when material flows are routed through a centralized node, the terminal, and cargo changes transportation mode through efficient terminal operations (Woxenius and Bärthel, 2008). These terminals play the most critical part in the whole intermodal logistics network, making them the key factor in achieving a competitive intermodal network (Goetz and Rodrigue, 1999; Woxenius and Bärthel, 2008; Netland and Spjelkavik, 2009).

Transaction cost theory in relation to intermodal transport focuses on the costs associated with transactions at the intermodal terminal. The founding concept by Coase (1937, p.395), and later Arrow (1969) defining transaction costs as 'the cost of organizing the economic system', has since been expanded and developed through substantial contributions related to transport, founding on explaining the organization and interaction between actors in a supply chain. According to Panayides (2002), transaction cost includes cost related to the acquisition and processing of information, the negotiation and design of contracts, and the monitoring and enforcement of the exchange relationship. There exist a substantial amount of approaches to model and simulate operational decision-making in transport, where most share the commonality of individual goals as opposed to mutual transport chain goals (Terzi and Cavalieri, 2004). The cooperation between independent companies for intermodal

terminal transactions experiences practical challenges as each actor has its own individual goals and priorities, utilizing different technological solutions, while no single model for risk and profit sharing exists. However, recent years' research by Ramstedt and Woxenius (2006) shows a shift towards a more holistic approach, e.g., the parallel and distributed simulation that can highlight the positive effects of cooperation between competing companies (Terzi and Cavalieri, 2004), and TAPAS, the hybrid micro-level simulator with its coordinating actor focusing on coordination between transport and production (Bergkvist et al., 2005; Davidsson et al., 2008). Fugate et al. (2009) argues that long-term and mutually beneficial relationships can lead to improved performance at the operational level, presenting a model that emphasizes the importance of supply chain relationships. This all accentuates the importance of the terminal and the efficient transactions with an integrated and cooperating strategy to enhance the performance of the freight transport chain.

Several authors have discussed whether transport distance has an impact on the competitiveness of intermodal rail-road transport (Trip and Bontekoning, 2002). Williams and Hoel (1998) says that 400 kilometers is the minimum for it to compete with road transport, while van Klink and van den Berg (1998) argue that 500 kilometers is the required distance. The 3 major destinations for railway traffic in Norway, Trondheim, Bergen and Stavanger, are each located between 450 and 550 kilometers from Oslo, with Oslo being in the center of the railway network. Regardless of this, transport economic research argues that any intermodal transport can compete with monomodal transports, short distances included, if transshipment were faster and less time consuming (Muller, 1996). Recent research shows that factors like innovations in the logistics network, freight proprietor's location in relation to the intermodal terminal and new services also influence an intermodal transport's competitiveness (Sommar and Woxenius, 2007). Trip and Bontekonig (2002) argue that innovative train operation principles and terminals offering low fixed cost is required in order to achieve competitiveness for small flows over short distances. Costs and time associated with post and pre haulage (PPH) have an effect on the break-even distance of intermodal transport compared to all-road transport (Bärthel and Woxenius, 2004).

There are a number of factors that can contribute to making intermodal transport competitive. Stabell and Fjeldstad (1998) list scale, capacity utilization and optimal routing as three of the most vital factors. The European Commission (2010) argues that increasing existing capacity by researching and utilizing advanced production processes and traffic control systems will also contribute to a competitive intermodal transport. Making the service more attractive to the end-users and offering more value-adding services than in traditional transport, stands out as some of the more intriguing research challenges for the intermodal terminal of the future (European Commission, 2010).

It is apparent that added services, cooperation and improvements throughout the intermodal transport chain will reduce transaction costs between the actors, thus strengthening the competitiveness of intermodal transport. Additionally, this would provide a basis for making intermodal transport competitive also for smaller quantities and shorter distances.

METHOD

This paper is a result from findings and analyses in the research project. The project deals with the value chain around the Alnabru terminal, Norway's main hub for rail freight transport. A main aim of the project initially was to map out challenges that some of the main actors around the Alnabru terminal experiences in terms of intermodal transport. These selected actors are the freight train operator and terminal operator CargoNet, the port authority of Oslo, and the two freight forwarders Bring Logistics and DB Schenker.

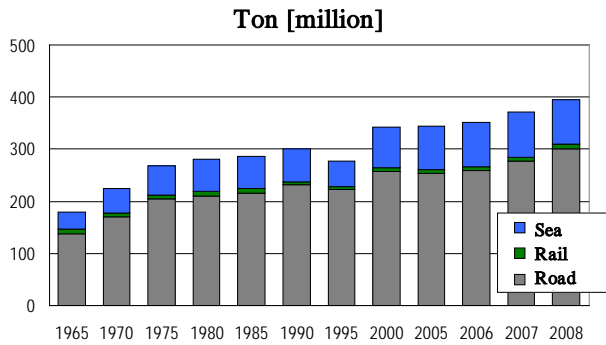
The research follows a case study methodology. The challenges were identified by on-site inspections and through interviews with some of the main actors in the Norwegian logistics network surrounding the intermodal axis between the port of Oslo and Norway's main intermodal terminal Alnabru. The findings of this paper are results of the mapping activities performed in close collaboration with logistics providers. The mappings focused on challenges related to intermodal transport and terminal operations, hence defining other challenges as irrelevant. The method used for the mapping activities is based on the Control Model Methodology (Alfnes, 2005; Alfnes and Strandhagen, 2000). Specifically, a macro/micro perspective was utilized. The macro perspective was employed initially, focusing on the intermodal production system, the merchandise owner's and the internal storage's value chains, and the physical conditions at the terminal to get a good overview of the situation. The micro perspective phase was then undertaken, where material flow, information flow and terminal layout was examined for each actor. This was to obtain a better understanding of the challenges and areas with potential for improvement. The challenges that were identified are described in the paper's findings.

The challenges were examined further during two workshops with participants from both the freight transport industry and academia in spring 2009. The workshops resulted in 28 described challenges where improvement activities could be initiated. Some of these activities had more or less congruent objectives, which led to a discussion among the project's academics, where merges were made among some of the improvement actions. The new list of challenges was then presented to the partners from the transport industry, who evaluated and prioritized the proposed improvement activities from their organizations' point of view.

CASE: THE ALNABRU INTERMODAL LOGISTICS NETWORK

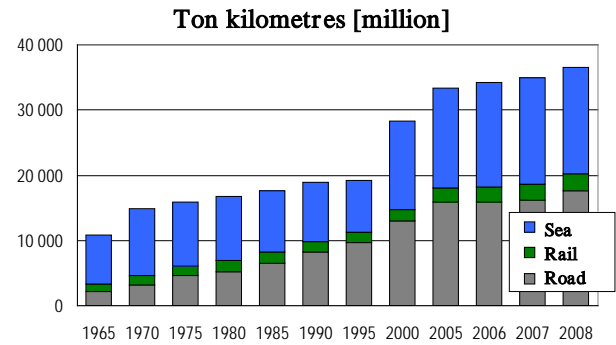
Intermodality in Norway has more or less been on top of the Ministry of Transport's political agenda since the mid 1980s, without great success in regard to a transportation shift towards rail and sea (Halseth, 2004). The National Transportation Plan 2010-2019 (NTP, 2009) underlines the national importance of the terminals at Alnabru and Oslo port, and the political support for increased intermodalism with Alnabru as national hub seems unambiguous.

The amount of rail freight transport in Norway has shown a rising trend, but the main portion is still transported on road. Figure 2 and Figure 3 shows that the total amount of freight transported in Norway on road, rail and sea has more than doubled since 1965, while transport measured in ton kilometers has increased by more than three times (Statistics Norway, 2010).



Source: Statistics Norway, 2010

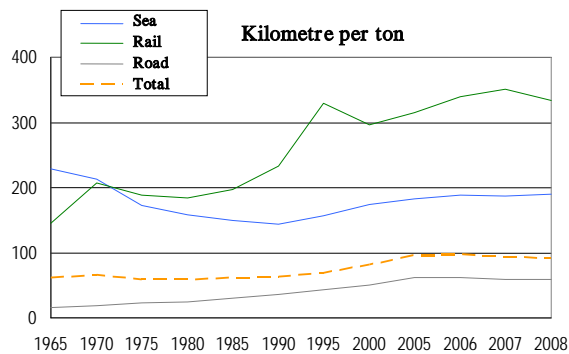
Figure 2: Millions of tons transported by sea, rail and road from 1965-2008



Source: Statistics Norway, 2010

Figure 3: Millions of ton kilometers transported by sea, rail and road from 1965-2008

The amount of freight transported by rail has been fairly stable and modest during the period shown in Figure 3. However, transport distances per ton, and thus the transport measured in ton kilometers has more than doublet (Figure 4). This shows that rail transport in Norway has captured more of the market for longer transports.



Source: Statistics Norway, 2010

Figure 4: Average transport distance per ton, by sea, rail and road from 1965-2008

A substantial portion of Norway's imported cargo arrives through the port of Oslo or by railway from Sweden through the Alnabru terminal. Jernbaneverket is the physical infrastructure owner of railways and terminals in the Norwegian Railway network. CargoNet is currently the biggest provider of rail freight traffic in Norway. Their main seat is at Alnabru in Norway's capital, Oslo.

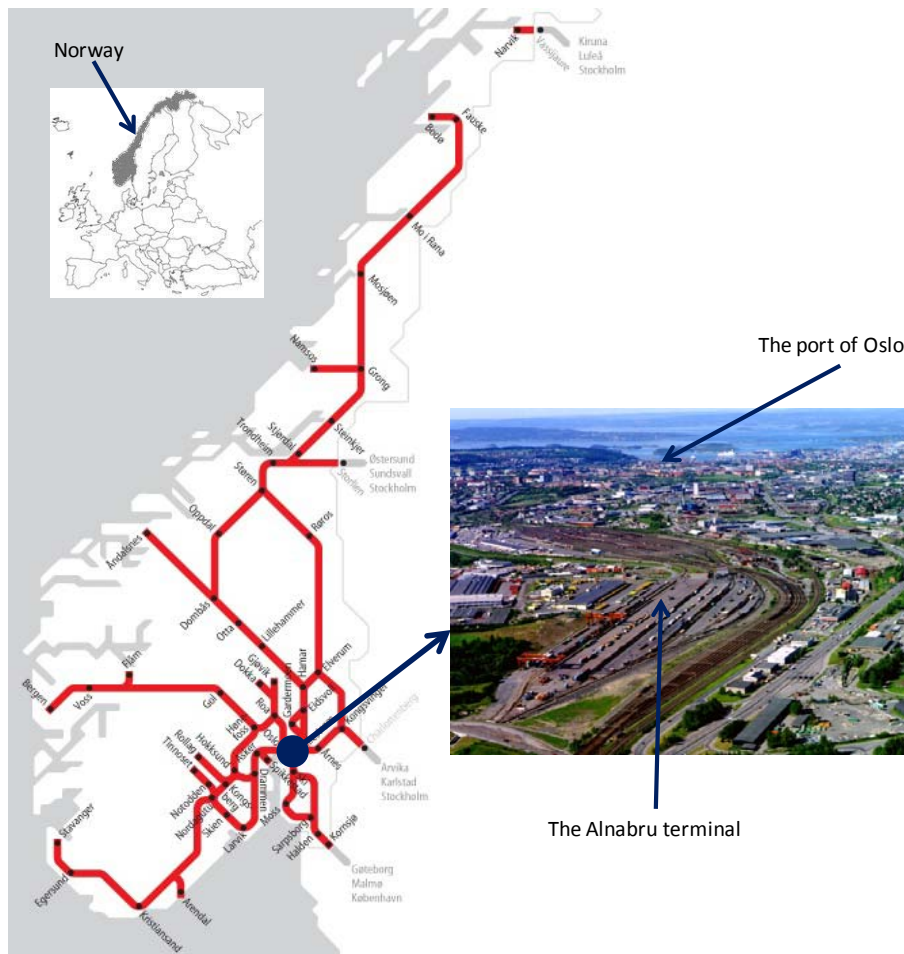


Figure 5 - The Alnabru terminal is centrally located, in Oslo near the capital's main freight ports

The red lines shown in Figure 5 illustrate the railway lines in Norway, with the Alnabru intermodal terminal as the heart of the railway network. The network is connected to 12 Norwegian rail freight terminals in total, including the Alnabru terminal.

The Alnabru terminal, the hub of Norwegian rail freight traffic, consists of a shared intermodal rail terminal operated by CargoNet, and three nearby freight terminals for cross-docking and consolidation of goods owned by the shippers Schenker Norway AS, Posten Norge AS (the Norwegian Postal Services), and Tollpost Globe AS. Posten Norge owns Bring Logistics with its cargo terminal less than 5 km away from Alnabru. Also Deutsche Post DHL is located only 5 km away from Alnabru. Moreover, Alnabru intermodal terminal is only 10 km away from the Port of Oslo, and today containers to and from the port is transported by truck. No manufacturing companies are located at Alnabru, but at a radius of 10-15 km warehouses of all the major Norwegian convenience chains and some dominant wholesalers are located (Eidhammer, 2007).

CargoNet is the terminal operator of the Alnabru intermodal freight terminal. Their five biggest customers, DB Schenker, Bring Logistics, Posten, Tollpost Globe and DHL, provide about 80% of all freight traffic through the terminal. In 2008 the terminal handled approximately 537.000 TEUs, totaling 90 % of Norway's rail freight traffic. According to

CargoNet there has also been an increasing amount of container traffic during the last two decades, from around 100,000 TEU in 1992 up to 580,000 TEU in 2008. This is estimated to continue increase substantially over the coming years.

Yearly, about 200.000 TEUs arrive at the port of Oslo by boat. The port authority of Oslo (Oslo Havn KF) owns the port area and its infrastructure, but the port itself is operated by different operators, e.g. OCT (Oslo Container Terminal). The port authority estimates that 85% of the received cargo at the terminal has its end destination in the Eastern Norway region. Currently, only 24.000 TEUs are forwarded directly from the port to the Alnabru terminal for further distribution. The rest goes to other logistics providers for transshipment. The biggest freight forwarders receive cargo at the port which is either delivered straight to the customer or to a central terminal for transshipment before it is transported further by road or railway.

In Norway, CargoNet has chosen a shuttle train design for intermodal transport, where fixed-formation train-sets operate specific origin-destination connections (Woxenius and Bärthel, 2008). This gives a basis for high reliability and cost-efficient operations because there is no need for time-consuming and complex shunting of wagons, and moreover, no need for complex OR-algorithms and expensive IT-systems. The cargo received at the Alnabru terminal is distributed to the other big cities in Norway on railway; Kristiansand, Stavanger, Bergen, Åndalsnes, Trondheim, Bodø and Narvik. CargoNet's vision is to enable shuttle trains with fixed number of container wagons every two hours to/from Oslo to/from the main cities Bergen, Stavanger and Trondheim (all distances >500km).

The terminal handles approximately 50 trains each day. Booking space for cargo on a CargoNet train is done online at a web-portal, whereas potential extra space is booked over the phone or by fax. At the beginning of 2008 about 30 % of the bookings were done through the web-portal. CargoNet offers 3 types of contracts to the freight forwarders:

1. Partner Plus: 6 month contract, fixed number of cargo spaces, cancellation not possible.
2. Partner: Fixed number of spaces that can be cancelled by noon the same day. 10-12 % more expensive than Partner Plus.
3. Flex: Ordered by demand each day in addition to fixed spaces. Same price as Partner.

The freight traffic at the terminal varies noticeably during the day. At times, especially in the middle of the day, CargoNet experience trains operating on half or low capacity utilization. The customers want to transfer freight transport from road to railway, but this is currently not possible due to capacity. Today, the terminal operates on 100 % of the capacity during peak hours (arrivals from 3am to 7am and departures from 6pm to 10pm) because of the established norm in market demand for overnight delivery. Outside of rush hour capacity is not exploited.

Jernbaneverket is the responsible organization for communicating delay warnings and deviations from train schedule. This is today a process of email communication, causing frustration among the train operator companies and freight forwarders. In general, the

communication in the value chain is based on phone, fax and email. There is limited sharing of information and common IT solutions, and no superior directing principles to guide the actors in the value chain. The chain has thus a low degree of flexibility, and the transition between modes is far from seamless.

CASE FINDINGS: CHALLENGES FOR INTERMODALITY

The freight forwarders want and have the opportunity to transport more cargo on railways. The general challenge is however that they need train capacity at the times when their customers want to transport cargo, freight trains leaving at peak hours in the evening to be at the end destination in the early morning. The Norwegian railway network is currently facing a lack of available capacity for trains, particularly through the Oslo area.

Together with more efficient link operations, new-generation terminals should improve the technical, operational, and economic feasibility of innovative bundling networks and thus enable the integration of small flows. Maintaining a high degree of delivery quality is of vital importance to the actors in the network. They also have a strong environmental profile, and are working to increase the amount of cargo transported on railways

Following is a list of findings from the mapping of some of the main actors in the intermodal transport network in and around the Alnabru terminal and the port of Oslo. The findings summarize experiences of challenges concerning intermodal transport in general, and address specific challenges from the actors' point of view for increasing the use of intermodal transport. The main challenges identified during interviews and on-site inspections are described in the following:

(1) Improving cooperation between the actors in the intermodal logistics network

In general, the logistics actors feel the need to identify new ways to cooperate both between Alnabru and the port area and also within each terminal area to make a more seamless transfer of cargo from sea to railway, and to increase cooperation with current and prospective users of intermodal transport. Some of the partners currently experiences that they have an unclear role at the terminal and in the value chain. This includes the role of accommodating efficient terminal operations as well as their responsibilities as an actor in the intermodal transport network. The responsibilities, activities and resources required for such role must also be defined. In effect this includes defining what organ the owner of a joint system for information sharing is.

The need for a mutual arena for the actors in the intermodal logistics network was identified. This is meant as a motivation for increased and maintained interaction between the actors. Establishing a user/contact committee that arranges operational meetings on a regular basis, where the network's performance is discussed and suggestions for improvement can be

presented. Such arena can be the foundation for mutually beneficial cooperation, planning and efficient cargo handling. The challenge also includes future organization of the intermodal transport network where ownership, free competition and splitting of terminal functions are some of the aspects.

(2) Improving communication of train and freight information to customers regarding arrival, loading/unloading window and deviations from plan

The freight forwarders experiences that the flow of information at disruptions in operations and delays in railway traffic is insufficient. Deviation messages are sent out to freight forwarders by email when a train is delayed. A large portion of these do not need this information as the situation might not involve their cargo. Suggestion for improvement includes a real-time information dashboard online, or to differentiate information that is sent out so that it only arrives at the correct receiver(s) that need the information.

This is a very important challenge to address as freight forwarders promise their customers correct information on delays and new arrival times. The communication between freight forwarders and their customers by utilizing new technologies is also a challenge to address.

Challenges concerning increased information flow also pertain to notification for train delays and new times for loading/unloading of trains. This information is often insufficient as it informs of estimated time of arrival instead of estimated time for loading/unloading of cargo. By discussing contract terms and adaptations, operations can become more efficient in terms of loading sequence, crane movement optimization and truck waiting time minimized.

(3) Improving IT-system interconnectivity and information sharing in general

All bookings for CargoNet trains are to go through the web booking solution. Because it currently is not properly suited for big customers, alternative channels for booking are used¹. A high degree of the communication goes through phone, email and faxes. The forwarders wish to put focus on developing the web booking solution so that it properly suits CargoNet's bigger customers, as they are responsible for about 80 % of Norway's freight traffic on railways. This also includes removing manual processes from the web booking solution, making the web booking and online portal for other real-time operations e.g. support through a chat function, and customizing system interface for ease of booking operations.

The forwarders do not have a sufficient overview of how many containers they will be able to send during the day, when they reach the deadline for confirmation of Partner spaces. This is because the day's incoming cargo is not registered at that time. They feel that this situation leads to non-optimal capacity utilization for peak hour train departures. The lack of overview is due to mixed cargo being sorted and loaded all the way up until the latest departures of the

¹ The challenge of alternative booking methods was mapped in spring 2009. In spring 2010 this issue has been solved, partly through the PROFIT project, and web booking is now the preferred booking method in more than 80 % of all bookings. Other cited challenges related to web booking are still valid today.

day. The forwarders want to use historical data to make demand forecasts to be better able to determine each day's demand. From an intermodal perspective prognoses can contribute to better capacity utilization of freight trains if the demand is easier to determine.

Cooperation between the actors in the logistics network is a central challenge to realize the intermodal logistics network of the future. Sharing information across organizational borders is essential to obtain efficiency throughout the value chain. This can be done through mutual EDI-solutions or an interface that ties the individual systems together and makes them able to communicate. Currently there are many time consuming manual operations for data storage, which includes many processes where data must be transferred manually between both internal and external IT-systems that do not communicate.

(4) Improving the efficiency of terminal operations in general

The freight forwarders have the need to increase the amount of cargo transported through intermodal terminals to meet their customers' demand. All actors must contribute in the development of intelligent solutions for cargo management in the logistics network. The solution must be available for all actors to use, and bring benefits to all users. More precise information in both directions between freight forwarder and freight train operator can contribute to improved capacity utilization. E.g. communicating that booked spaces on a train will not be used, making them available to other freight forwarders. Some actors also want to investigate whether the deadline for confirming booked spaces has to be set at noon or if it could be postponed. Other suggestions include keeping the focus on the whole value chain when optimizing, which could entail standardizing the cargo carrier and implementing automated identification.

Capacity at peak hours has reached its limit. The foremost challenge entails spreading the traffic over the day to cut the highest peaks and send more cargo at times with less traffic. This will typically be cargo with lower priority in terms of conveying time. The introduction of new pricing models can help turn the demand around. Revisiting contractual agreements and booking policies can also contribute to this. Ideally, if demand did not make evenings for sending and mornings for receiving, a situation where a train was both unloaded and loaded simultaneously might lead to a better utilization of the terminal's loading tracks and thus terminal capacity. This would also lead to a better utilization of the trucks delivering and picking up the cargo, and reduce the empty truck transport.

The current situation at Alnabru leaves unexploited train departures at daytime. The utilization of trains outside peak hours is considered to be a vital challenge to the intermodal transport network around Alnabru, as new solutions to shifting some of the market demand to earlier departures will increase the capacity of the terminal. The solution requires better communication between the freight forwarder and the freight train operator. A possible way of solving the challenge can be to place fully loaded containers at the terminal and use them as buffers to fill trains with available capacity. This will lead to earlier conveying of cargo and a more even production at the end terminals. Today's policies and price strategies for container storage inhibits such solutions for flexible capacity utilization. A more even

transport production can reduce the amount of required terminal equipment and increase capacity utilization of the remaining equipment.

(5) Developing cooperative depot management

Establishing joint depots as buffers to obtain a more steady flow of terminal operations has potential to increase throughput times and lower overall inventory in the network. A part of the depots should be within reach for the terminal gantry cranes to reduce handling costs. Currently, area limitations and too few loading tracks cause extra handling of cargo, intermediate warehousing and delays in production. A possible counter to this challenge is price differentiation for depot storage, as this can reduce storing and thus also the number of container handlings at the terminal. A mutual depot for the port authority, train operators and the freight forwarders located at Alnabru or in the vicinity is also considered. The increasing demand for transport and Norway's large portion of non-stackable containers (including semi trailers) create challenges concerning land utilization.

As container placement is both a competitive advantage for freight forwarders and a storage cost for the port authority, it is important to manage the storage of empty containers and use fitting measures to control and keep down the quantity. Cooperation between the port and Alnabru should be considered.

The freight forwarder has had challenges with containers being forgotten in transit and left at the transit station. This has led to that booking each transport in single stretches where they themselves see to it that the container is sent on the next train to the end destination. This brings additional costs and additional activities for the freight forwarder and the terminal operator. There is need for better routines for containers in transit to deal with the experiences challenges.

(6) Automation of manual check points in the material flow

The mapping of the cluster at Alnabru terminal revealed a disparity between the number of produced cargo transports and the number of passing through the access gates at the Alnabru terminal. This indicates that a large amount of trucks carrying cargo to and from freight forwarders' terminals and Alnabru only bring cargo one way and go back the other way without anything to carry. This is due to little or no planning of truck transport assignments and truck utilization.

In order to increase capacity through the terminal access gate, increase data security and increase the data flow it is vital to develop a new system for automated access control. Investment in new technology will be a central focus area to track and trace material flow, increase information quality, and serve as a foundation for automatic access gate control. The aim is to make the transport service more attractive to the end customer by offering improved information, status updates on orders and deliveries, and lower logistics costs through better resource utilization. Addressing this challenge can also include implementing a pre-transport planning system to create a better operative base for planning. Exploring the

possibility of executing safety and commercial controls earlier in the value chain is an important part of this, and can lead to increased area utilization and a reduction in empty truck transports.

High-quality access to the terminal is a very important challenge to address. This includes access gates with a system for identification, tracking and security, as well as the entry into the terminal area. The coordination of these three aspects is part of the challenge regarding terminal access. The forwarders also want to explore opportunities to gain direct access by automated information delivery and performing safety and quality checks at their own terminal.

RECOMMENDED ACTIONS FOR IMPROVEMENT

This chapter describes possible actions that can lead to improvement for intermodal logistics networks. The actions represent the priorities of the logistics providers in the PROFIT project. Being a user-managed innovation project entails that the project is largely influenced by the users and what they consider to be in the consortium's best interest. The decision process involved both users from the industry and academics, making it a balanced process between both practical and visionary aspects. The decision was to initiate five improvement activities. The selected activities and their justification for selection are described in the following subchapters, and are arguably a mirror of what academics and practitioners from the transport industry currently considers the most important challenges facing intermodal logistics today.

Table 1 - PROFIT action plan to address challenges

Short term quick-wins	Long term strategy
a) Automated Access Gate Management b) Automated Electronic Invoice System c) Online Booking System	d) The Intermodal Terminal of the Future e) Holistic Performance Management System

The priority of the five presented activities were set from a consideration of what is important for the intermodal cluster in a long term perspective compared to less extensive quick-wins that can contribute to early improvement effects. In the discussions of challenges and improvement activities, a decision was made to focus on both specific and generic challenges, but to keep a good balance between short term and long term focus. Emphasis is put on utilizing the tension between the specific and the visionary in order to drive the project forward.

Short term quick-wins

The short term quick wins were chosen to address some of the vital challenges unfolded during case studies of the involved logistics partners of PROFIT. The activities were chosen after a thorough examination of the identified challenges from the case studies. The intermodal logistics cluster felt the need to attain some early quick-wins to improve the current situation of the intermodal logistics network, and to advocate intermodal transport instead of experiencing sub optimization of each actor in the cluster.

a) Automated Access Gate Management

This action involves developing a system for automated gate access by utilizing solutions for electronic identification in order to make gate access more efficient, ensure efficiency within the terminal and optimize utilization of trucks and cargo carriers. Results from this activity will contribute to the development of an efficient intermodal terminal system. This activity will, along with the implementation of an automated IT-solution for gate access registration, provide the foundation for including the access gate in the holistic performance management system. The development also involves exploring the opportunities of utilizing the latest of auto-id technologies giving visibility such as RFID, AVL, GPS, DGPS (Differential GPS) (Netland and Spjelkavik, 2009), that will enable track and trace of trucks, cargo carriers, terminal equipment and personnel within the terminal.

b) Automated Electronic Invoice System

This improvement activity addresses the need to develop an invoice system that automatically creates invoices when transactions or activities are registered and performs controls against the internal booking systems². The industry and academics consider this an important part of making information flow and thus making intermodal transport more efficient. A fully functional automated electronic invoice system will reap great financial benefits for the involved actors, and contribute to the cluster by offering efficient and accurate invoicing with a minimal need of manual processing.

c) Online Booking System

The current booking process is outdated³. This action involves the development of an online booking system that ensures full utilization of available train capacity, contributes to efficient resource utilization of administrative services in the logistics network, as well as ensuring an efficient material and information flow through the supply chain. The aim is to obtain real-time booking similar to the systems used for booking in the aviation industry and thus provide the customers with value-added services with a minimal need of manual processing.

² The challenge was mapped spring 2009. During spring 2010 EDI-billing has been implemented..

³ The challenge of alternative booking methods was mapped in spring 2009. In spring 2010 this issue has been solved as web booking is the preferred booking method in more than 80 % of all bookings. Other cited challenges related to web booking efficiency are still valid today, and suggested improvement actions are given.

Long term strategy

In order to address the overall challenges that were uncovered, an evaluation was undertaken to see what actions would be most beneficial for the cluster in a long term perspective, moving the cluster towards the vision of an efficient and competitive intermodal logistics network. The decision fell on two activities that focus on an intermodal system that accommodates and nurtures network cooperation across organizational boundaries and raises the performance of the whole cluster of organizations instead of causing sub-optimization.

It is important to note that the following two strategies are merely two prioritized long term actions chosen by the Alnabru cluster. The selection is by no means an excluding list. Further research will reveal other long term strategies for the cluster, but the following two strategies are the ones that will be addressed in the remaining project period.

d) The Intermodal Terminal of the Future

The Intermodal Terminal of the Future aims to develop a holistic generic model for terminal operations for intermodal transport with the demands and requirements of an optimal performing logistics network. This can be done by painting a picture of the parent network cooperation in the intermodal cluster, including objectives for effect within the different operational areas of the terminal. The Control Model Methodology is considered a useful tool for painting this picture. The activity has a three-fold perspective, needing to address challenges related to the current practices and demands in logistics, challenges related to future demands in a 10 year perspective, as well as a visionary logistics situation on a 50 year horizon.

e) Holistic Performance Management System

Performance Management and measuring performance is an important tool in all improvement activities. Related to efficient terminal operations, a holistic and mutual performance management system is vital to be able to evaluate how efficient the terminal really is. The system will also help to identify areas where improvements are needed, monitor the effects of improvement and development work and improvement measures that are initiated. The challenges within this activity includes mapping the key performance indicators that are measured and the potential performance management systems that are in use today by the individual actor organizations, developing a set of key performance indicators for an efficient intermodal logistics network, and using the mentioned indicators to develop a performance management system that is accessible and visible to the whole cluster, and instigate an efficient intermodal network that encourages cooperation between all involved actors.

CONCLUSIONS

This paper has presented six challenges that the Norwegian intermodal logistics industry are currently facing on the way to becoming an efficient intermodal logistics network. These challenges have been analyzed and evaluated by both the industry and academics, where consensus was on addressing these challenges with three short term and two long term improvement activities. The aim of focusing on these activities are to move towards an efficient intermodal logistics network by improving material flow, improving information flow and obtaining a mutually beneficial cooperation within the logistics network. The mapped challenges are:

- 1) Improving cooperation between the actors in the intermodal logistics network
- 2) Improving communication of train and freight information to customers regarding arrival, loading/unloading window and deviations from plan
- 3) Improving IT-system interconnectivity and information sharing in general
- 4) Improving the efficiency of terminal operations in general
- 5) Developing cooperative depot management
- 6) Automation of manual check points in the material flow.

Practical implications and further research

By presenting the challenges, the authors hope to raise the awareness of some of the challenges the industry are faced with, especially in countries similar to Norway. It is important to consider that all the processes are highly interconnected and that changes in parameters in one process also have an impact on parameters in other processes. Furthermore the performance of intermodal terminals, as they can be seen as the backbone of the system (Netland and Spjelkavik, 2009), has a significant impact on the overall performance of the whole transportation network.

Cooperation between the actors in the intermodal logistics network is a vital part of the future intermodal transportation in Norway. Interaction between the organizations and the exchange of important information will offer great returns for the involved actors. It will make it possible to plan operations to a much greater detail, and thus both operate more time efficient and utilize more of the available capacity.

The paper suggests five activities to be addressed for the development of the Norwegian intermodal logistics cluster:

- a) Automated access gate management
- b) Automated electronic invoice system
- c) Online booking system
- d) The Intermodal Terminal of the Future
- e) A Holistic Performance Management System for the cluster

Further research will reveal other long term strategies that will be beneficial for the Alnabru cluster. Addressing the listed activities as well as revealing new short and long term strategies for the Alnabru cluster will be a priority for the remaining part of the project period.

Limitation of study

The paper considers aspects on intermodality in Norwegian industries only. Due to the special characteristics of Norway with relatively small population, long transport distances, scattered settlement and long coast line, the generalization to other countries must be done with caution. This paper fills a gap in literature by giving a Norwegian perspective on the current state of intermodality in the industry. Moreover this paper takes a holistic perspective by mapping challenges that the actors in the intermodal transport industry face.

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