



# Factors facilitating intermodal transport of perishable goods - transport purchasers viewpoint

Thor-Erik Sandberg Hanssen <sup>1\*</sup>, Terje Andreas Mathisen <sup>1</sup>

<sup>1</sup> Bodø Graduate School of Business, University of Nordland, NO-8049, Norway

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## Abstract

The aim of this article is to identify factors that facilitate increased use of intermodal transport for perishable products based on a survey of firms exporting fresh fish from Norway to Continental Europe. The experiences in the Norwegian aquaculture industry indicate that intermodal transport solutions must be expanded and that the long haul by rail must run all the way to a central hub in Europe. This can only be achieved with a balanced flow of goods and if processors coordinate transport to deliver sufficiently large volumes to fill trains at an acceptable frequency.

*Keywords:* Intermodal transport; Rail; Fresh fish; Perishable goods; Export; European regions.

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## 1. Introduction

The promotion and development of intermodal transport solutions, defined as the movement of goods in a single loading unit or vehicle that successively uses two or more modes of transport without handling the goods themselves in changing modes (UN/ECE, 2001, p. 17), is considered by the European Commission (2009) to be an important contribution to achieving a sustainable European transport sector.

The main advantage of intermodal transport solutions is their comparatively low external costs. It has been estimated that the total external cost of an intermodal train per tonne-km, including the cost of accidents, air pollution, greenhouse gases and noise, is only 28% of the external cost of a general freight truck (Forkenbrock, 2001). If focusing purely on greenhouse gases it is estimated, using transport between Basel and Rotterdam as an example, that CO<sub>2</sub> emissions from transport by waterways are four times higher and by lorry eight times higher compared to that of rail (UIC, 2008). Naturally, the results of any comparative study of the external costs of transport solutions will be affected by the types of external effects taken into consideration

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\* Corresponding author: Thor-Erik Sandberg Hanssen (thh@uin.no)

(Quinet, 2004). One obvious omission made by Forkenbrock (2001) is the cost of congestion. Given that the external cost of congestion is higher for road-only transport than for intermodal transport, the actual difference between the external costs for intermodal and road-only solutions may be even greater. Moreover, it has been argued that intermodal transport reduces transport costs because the most suitable transport mode is used on each part of a trip, thereby increasing national competitiveness through increased economic productivity and efficiency (OECD, 2001).

In Europe, intermodal freight transport can be divided into two groups: ocean liner trade and inland trade. Whereas intermodal ocean liner trade in Europe has been deemed a success, this has not been the case for inland intermodal transport (Stone, 2008). Between 1996 and 2006 the total freight volume (measured in tonne-kilometres) transported on the roads of the European Union (EU) grew by 45%, whereas transport by rail and by sea increased by 11% and 33%, respectively (European Environment Agency, 2009). This increase rate indicates that the policies implemented to promote intermodal transport have had limited success (Janic, 2007; Konings et al., 2008) and that the potential for transport by rail and water has barely been exploited (van Reeve, 2005). The unsatisfactory development of intermodal rail transport has been linked to substandard infrastructure, lack of interoperability, fragmented operational control, a lack of connection between operational control and responsibility, and unclear and rapidly changing institutional arrangements (Tsamboulas, 2008), which have generated concerns about the reliability, capacity, speed and flexibility of the rail network (European Commission, 2007).

Distance and the type of goods to be transported are the most important determinants of the transport mode chosen (Blauwens et al., 2006). The attractiveness of an intermodal road-rail transport solution depends on the extent to which the relatively low cost of rail transport offsets the extra cost of pre- and post-haulage and necessary transshipments (Bärthel and Woxenius, 2004). A decade ago, intermodal transport solutions were attractive for distances in excess of 500 km (van Klink and van den Berg, 1998). However, during the last decade Tsamboulas (2008) suggests that the minimum distance has fallen to 400 km. The break-even distance will vary both with the properties of the consignment and the transport services (Janic, 2007).

Specific challenges for implementation of intermodal transport between Norway and Europe are the heavy, and steadily increasing, unbalanced flow of goods (Hovi et al., 2008) and the high number of small loading units (Ludvigsen and Klæboe, 2010). The unbalanced flow, following the high imports relative to exports, would provide low average capacity utilization in intermodal transport solutions and make it difficult to achieve profitability. The problems related to small quantities could, according to Ludvigsen and Klæboe (2010), be approached by designating a number of terminals in Europe as “rail ports” where goods to and from Norway are handled to generate larger volumes and fewer rail stops. Also Wichser et al. (2007) emphasize the benefits for intermodal transport by reducing the number of participants in the supply-chain when studying east-west corridors in Europe. Sufficiently high service frequency is important and presupposes substantial and regular demand, see e.g. Janic (2007). This can be more easily achieved if players are consolidated.

One category of goods that requires special attention during transport is “perishable” or “deteriorating” goods such as fresh fish, flowers and fruits, which are particularly time-sensitive and fragile. Because intermodal transport solutions rely on time-consuming transshipment, they are at a disadvantage compared with all-road transport

(Sommar and Woxenius, 2007). In addition, transshipment requires movements that may damage fragile goods. Currently, the intermodal transport of perishable goods is very rare (Bontekoning and Priemus, 2004); namely, there is a substantial growth potential if the obstacles caused by sensitivity to time and fragility can be handled.

The aim of the article is to study the experience of the Norwegian aquaculture to advice policymakers regarding measures that would increase the use of intermodal transport solutions for fresh fish specifically and perishable goods in general.

The article is organized as follows. Section 2 briefly presents the literature on intermodal transport and identifies a number of factors particularly relevant for fresh fish. Then, in Section 3, the empirical data from the Norwegian aquaculture industry are presented. The data are analysed in Section 4. Finally, concluding remarks including notes on strategies for achieving increased use of intermodal transport of perishable goods are provided in Section 5.

## **2. Intermodal transport of perishable goods**

The literature defines intermodal transport as the movement of cargo/products using more than one mode of transport (Bontekoning et al., 2004). Hence, the transfer of goods between transport modes is required, and the transfer must be conducted efficiently at the terminals to make intermodal transport solutions competitive (Woxenius and Barthel, 2008). Improved cooperation and interaction between the organizations that operate and use the terminals can help operators to plan terminal operations better and thereby run them more efficiently (Stokland et al., 2010).

According to Stone (2008), improved interconnectivity and interoperability are critical success factors for intermodal growth. However, interconnectivity and interoperability are difficult to achieve because the current European transport system is the result of 150 years of development and is affected by perceived needs, private and public initiatives, wars, funding, and national policies of support and intervention. This long trajectory has resulted in 37 different combinations of rail gauge, tunnel clearance and power systems across Europe (Tsamboulas, 2008).

Dedicated information on the specific challenges associated with the intermodal transport of perishable goods is hard to find, as are recommendations regarding how such transport can be facilitated. Irrespective of the length of the journey, perishable goods are typically transported by road (Blauwens et al., 2006). The predominance of this method is in part due to the flexibility that it offers regarding “door-to-door” deliveries (Blauwens et al., 2006) and the time factor involved due to the possibility of deterioration of the goods in question. The importance of time when transporting perishable goods is visible in rough assessments of price reductions of between 20 and 25% for fresh fish delayed in transit by 48 hours (Lervåg et al., 2001).

Although improved refrigeration technology has made the time factor somewhat less critical (Nordtvedt, 2009), perishable goods continue to be particularly sensitive with regard to on-time reliability (Patterson et al., 2008). Temperature largely determines the rate of microbial activity in fish (Giannakourou et al., 2005) and thereby the quality and safety of fish products. Therefore, cold chain management is important to keep fish products safe and to maintain their economic value (Tingman et al., 2010). However, it has been recognised that transfer points are weak links in chilled perishable food

management (Nychas et al., 2008). This means, *ceteris paribus*, disadvantages for intermodal transport as compared to unimodal transport.

To realize real growth in the perishable goods market, which, according to Bontekoning and Priemus (2004), is among those with the highest growth potential, shorter transport time will be necessary on the rail haul segment of the transport chain, as will shorter processing time at the terminals, delay control, more and better transport relationships and increased service frequency (Bontekoning and Priemus, 2004).

Table 1 presents the main factors affecting the successful use of intermodal transport to be studied further in the empirical context of exported Norwegian aquaculture products. The list is based on factors identified in the EU project PROMOTIC (2000) and challenges that are particularly relevant for the export of fresh fish from Norway based on market knowledge.

Table 1: Facilitators for intermodal success with transport of fresh fish.

<i>Factor (abbreviated title)</i>	<i>Comments and explanations</i>
<i>Properties related to interconnectivity</i>	
Terminal proximity	Terminal must be located close to the farming plant
Terminal capacity	Terminal must have sufficient capacity
Terminal access	Terminal must be easily accessible from the main road network
<i>Properties of the transport solutions offered by the transport/export companies</i>	
Include rail	Rail must be included in the transport solutions offered by the export companies
Rail to Europe	The long haul trip by rail must go all the way to a central hub in Europe
Continuous cooling	A continuous cooling chain is required to maintain the freshness of the goods
<i>Properties of close substitutes</i>	
Road price	Increased price on close substitutes will make rail more attractive
Sea price	
<i>Quality aspects of the rail haul</i>	
Rail speed	Increased speed, frequency, punctuality will make rail-based transport solutions more attractive
Rail frequency	
Rail punctuality	
Rail price	Price must be competitive compared to other transport solutions
Rail capacity	Capacity on rail must be increased to make rail a better alternative
Rail customer service	Suppliers of rail-based transport solutions must improve their customer support
Rail environmental friendly	Rail provides more environmental friendly transport compared to pure road transport solution

The factors are categorized into four groups focusing on the properties of (1) the terminals where the cargo is loaded, (2) the transport solutions offered, (3) close substitutes and (4) quality aspects of the rail haul. The 15 factors identified in Table 1 form the basis for the subsequent analysis in Section 4 of means to increase the use of intermodal transport for the export of farmed fresh salmon from Norway to Continental Europe.

### 3. Empirical Data

According to the Norwegian National Rail Administration (2008), the railway network had in 2007 a track length of 4114 km, of which only 227 km (5%) is double track. Over the next decade, there are plans for investments in more double tracks and improved traffic control systems to ensure improved efficiency (Norwegian Ministry of Transport and Communications, 2009). The railway network illustrated in Figure 1 shows several connections from selected terminals in the coastal areas in the Western and Northern parts of Norway, where the aquaculture industry operates, to the national terminal in Oslo. The main provider of transport capacity at these terminals is CargoNet AS with more than 99% of the domestic “tonne-kilometers” in 2007. Transport of iron ore by Malmtrafikk AS from Northern Sweden to Narvik for further shipment by ship makes up the major portion of cross-border traffic.



Figure 1: The Norwegian railway network with selected important terminals for domestic transport of aquaculture products.

Source: Mathisen et al. (2009).

### *3.1 The Norwegian Salmon Export Industry*

Norway is one of the largest exporters of fish commodities (FAO, 2009), second only to China, and Continental Europe represents one of the main markets. In 2008, the export value of Norwegian salmon exceeded 18 billion NOK, and almost all of that salmon was produced by the aquaculture industry and sold fresh (Norwegian Seafood Export Council, 2009). Transport patterns for exported fish can partly be found in statistics gathered by the Norwegian Customs Department and prepared for analysis by Statistics Norway. The data includes county of origin, border crossing and expected destination. With respect to the border crossing, details are given regarding name of customs station, transport mode, type of goods, weight and value. However, these data are based on planned transport route prior to departure of the shipment. Hence, redirections of transports on-route are not captured in this data set. Mathisen et al. (2009) corrected for this weakness by interviewing fish farmers about their transport patterns and concludes that salmon exported in 2007 mainly crossed the border on articulated vehicles (77%), with smaller quantities on boats/ferries (15%) and airplanes (8%). In contrast, no fish crossed the Norwegian border by rail.

Even though most transport of fresh fish currently are carried out by lorries or articulated vehicles, a considerable proportion of domestic transport, especially from the Northern part of Norway, are transported by rail. Mathisen et al. (2009) estimate that about 70000 tonnes of the total exported volume of 520000 tonnes were transported domestically by rail in 2007. The majority originate from the Northern part of the country and end in the Southeastern part of Norway, where the fresh fish is reloaded to trucks for further transport to the markets in Continental Europe. All fresh fish exported from Norway to Continental Europe is transported longer than the 400 km considered to be required for intermodal transport solutions to be competitive. Thus, it could be expected that at least some of the exported fresh fish might be eligible for efficient intermodal transport during the international portion of the trip.

### *3.2 Data Set*

Information about the use of rail-based intermodal transport was gathered from managers at Norwegian farming plants and exporters of aquaculture products using a web-based questionnaire. The questionnaire was designed to reveal the managers' experiences with rail-based intermodal transport and which factors they consider most important to further increasing their use of such transport solutions.

The email addresses used to distribute the questionnaire to the respondents were collected from two sources. The Norwegian Seafood Federation, an interest organization for the aquaculture industry, provided a list of email addresses for all member farms. The email addresses for the exporters, on the other hand, come from the Norwegian Seafood Export Council, which maintains a publicly available register of all companies allowed to export sea food, including their email addresses. Because all exporters of seafood must by law be enrolled in this register, it represents the total population, and there is in practice no bias involved because all firms have email addresses. As presented in Table 2, the questionnaire was sent to 665 firms, including both farmers and exporters of seafood.

Table 2: Details about response rate and products.

	<i>Selection (no. of firms)</i>	<i>Responses</i>	<i>Response rate</i>	<i>Products<sup>a</sup></i>			
				<i>Salmon</i>	<i>Cod</i>	<i>Trout</i>	<i>Halibut</i>
Farmers	250	43	17,2 %	58%	33%	26%	12%
Exporters	415	70	16,8 %	23%	24%	11%	16%
Total	665	113	17,0 %	36%	27%	17%	14%

Note: <sup>a</sup> indicates the fish products handled by the respondents. Each respondent could have more than one product.

Web-based surveys have long been recognized as taking less time and costing less money than more conventional survey methods (e.g. Schmidt, 1997), but they typically have low response rates (Cook et al., 2000). As shown in Table 2, a total of 113 respondents answered the questionnaire, yielding a response rate of 17%. However, because the respondents were not obliged to answer all of the questions, there are some missing values for some of the questions. A large portion of both the firms selected and the responders were exporting firms.

These firms often handle more than one product. Fresh salmon, provided by 36%, is most frequently indicated as one of the respondents' main products. Also, other fresh aquaculture products such as cod, trout and halibut are important products for both farmers and exporters. A mixed group of different frozen fish, shellfish and other white fish also makes up a sizeable portion of the total product portfolio, particularly for exporters. With respect to geographical distribution, the sample includes respondents located in all counties along the coast from the Southwest of Norway to the Northeastern border with Russia. The data set captures the variation in firm size found in the industry, with annual volumes ranging from 6 tonnes for small seasonal operators to 170000 tonnes for multinational companies listed on the stock exchange (with an average of about 13000 tonnes).

## 4. Analysis

### 4.1 Deciding on Transport Mode and Transport Route

Transport by road from Norway to Europe has increased with rising exports and imports (Hovi et al., 2008). In the case of aquaculture products, several actors are involved in choosing transport modes and transport routes from processing plants in Norway to customers in Continental Europe. Hence, an important question to address when seeking to identify policy measures that can contribute to the increased use of intermodal transport is who decides on the transport mode and route.

The value chain for farmed salmon starts with the production of fish feed and continues with the cultivation and breeding of the fish at the hatchery before they are farmed and processed. Then the fish is sold by exporting companies and transported (primarily by road) to customers abroad. It is not unusual for large companies in this industry to vertically integrate parts of the logistical chain, from hatcheries to exporters, with further vertical coordination with supermarkets (e.g. Kvaløy and Tveterås, 2008).

The respondents were asked to indicate to what degree six different actors in the logistical chain influence the chosen transport mode and route. Because they are not directly related to the export of fresh fish, the actors involved in the early fodder and hatchery stages were not considered. Still, one option was to indicate whether other participants in the logistics chain influence the choice of route and transport mode. The actors are as follows (sorted according to the transport chain for aquaculture products):

- Farmers – The companies producing the fish (breeder)
- Processor – The companies processing the fish (slaughterhouses)
- Exporters – Sales companies
- Transporters – The companies offering transport solutions to the exporters
- Railway companies – The suppliers of rail services (firms that own and run the trains)
- Customers – The retailers located in Continental Europe (fish buyers)

Responses were provided on a scale from 1 (no influence) to 5 (a decisive influence). The respondents' impression of the influence each actor has on mode and route choice is presented using mean values in Table 3 accompanied by the number of responses and standard deviations. In the survey, the rating for each factor was accompanied by an explanation stating the meaning of each number, with the value 3 representing neither a low nor a high degree of influence. This ordinal scale does have its limitations with respect to econometric analysis in that it produces non-metric data (e.g. Hair et al., 1998). It is, however, clear that a rating of 3 is better than a rating of 2. In the following analyses, it is assumed that the respondents perceive the differences between the grades as equal so that average values can be calculated. The varying number of responses for the role played by each actor, ranging from 68 (other) to 98 (exporter), occurred because the respondents were not forced to answer all of the questions. Standard deviations are used to indicate the variation in the answers.

Table 3: Respondents view of the influence of actors on choice of transport mode and route.

<i>Actor</i>	<i>Transport mode</i>			<i>Transport route</i>		
	<i>Responses</i>	<i>Mean</i> <sup>a</sup>	<i>Std. dev.</i>	<i>Responses</i>	<i>Mean</i> <sup>a</sup>	<i>Std. dev.</i>
Exporter	98	4.6	0.8	91	4.1	1.2
Customer	95	3.5	1.4	91	3.5	1.5
Transporter	90	3.4	1.4	92	4.1	1.3
Processor	96	2.5	1.5	95	2.2	1.4
Farmer	85	2.4	1.4	84	2.0	1.2
Railway firm	84	2.2	1.3	83	2.2	1.3
Other	68	1.5	0.9	68	1.4	0.9

Note: <sup>a</sup> 1= no influence, 2= low influence, 3= neither low nor high influence, 4= high influence, 5= decisive influence.

It is evident from Table 3 that exporters have the most influence on choice of transport mode (score 4.6). This is reasonable because exporters often choose from



among transport solutions offered by several transporters. The relatively low standard deviation for the exporters indicates that there is a high degree of agreement among the respondents that this actor decides on the transport mode. Also, customers (score 3.5) and transporters (score 3.4) greatly influence the choice of transport mode. Even though the same three actors have the main influence on the chosen transport route, the values presented indicate that the influence on choice of transport route is more evenly distributed than that on choice of transport mode. Processors, farmers, and railway firms have little influence regarding the choice of mode and route. The fact that the “other” category is given close to no influence indicates that the six other actors wield virtually all of the influence.

Hence, if policymakers want to alter the chosen mode of transport for aquaculture products, their efforts should be primarily aimed at exporters. If the aim is to influence route choice decisions, however, the transport companies are equally important to address.

#### *4.2 Means to Increase the Use of Rail in Transport of Fresh Fish*

The respondents were asked to state to what degree the 15 factors identified in Table 1 influenced their choosing rail as the long-haul transport mode. The scale ranged from 1 (no importance) to 5 (high importance) with a score of 3 representing “some influence”. The statements are ranked in Table 4 according to mean value, with the number of respondents varying between 34 and 38 because the respondents were not forced to answer all questions. The respondents were about 80% farmers and 20% exporters.

Table 4 indicate that almost all factors are considered to have a substantial influence on the use of rail-based intermodal transport solutions. The exception is the price of close substitutes such as sea and road transport, which is assessed to be of little importance. Such a conclusion with respect to pricing of other transport modes is supported by Ivaldis’ (2007) theoretical discussion of the effect on rail transport by introducing a road toll. The low importance, however, could be due to tactical answers by respondents hoping to avoid increased prices on current transport solutions.

As argued in Section 2, the need for an unbroken cooling chain (continuous cooling) is a decisive factor in making rail-based transport a viable alternative for the transport of fresh fish and other perishable goods. Equally important is the fact that too few rail-based intermodal transport solutions are offered and that none of them provide a long-haul service to Continental Europe by rail. Also, certain aspects of the terminals where the fish is loaded on the rail are considered important. The respondents claim that the use of rail services will increase for this type of goods if the terminals are located closer to the farmers and if access from the main roads improves. With respect to the terminals themselves, it should be noted that farmers and processors of aquaculture products are often located on islands or in other rural areas along the coast, whereas the railway infrastructure is located much further inland. This explains why improved terminal proximity and accessibility will be necessary to make rail transport a genuine alternative. However, it is also worth noting that intermodal terminals need a critical catchment area for efficient operations (Bergqvist et al., 2010). Improved proximity might reduce average catchment area for the terminals and might thus also reduce their efficiency. Aspects of rail-based service such as speed and frequency are also considered to have a considerable degree of influence.

Table 4: Respondents assessment of statements regarding increased use of rail-based intermodal transport of fresh fish from Norway to central Europe.

<i>Statement</i>	<i>Responses</i>	<i>Mean value</i>	<i>Std. dev.</i>
Continuous cooling	36	4.2	1.2
Include rail	38	4.2	1.0
Terminal proximity	38	3.9	1.2
Rail to Europe	36	3.9	1.0
Rail speed	37	3.8	1.1
Terminal access	36	3.7	1.1
Rail frequency	37	3.6	1.2
Rail punctuality	36	3.4	1.2
Rail environmental friendly	35	3.4	1.1
Terminal capacity	35	3.4	1.3
Rail customer service	36	3.3	1.1
Rail price	36	3.1	1.3
Rail capacity	34	3.0	1.2
Road price	36	2.5	1.1
Sea price	35	2.3	1.1

Note: <sup>a</sup> 1= no influence, 2= low influence, 3= some influence, 4= considerable influence, 5= high influence.

Based on the responses given by farmers and exporters, it becomes evident that farmers tend to consider each factor as having a greater influence on the use of rail-based intermodal transport solutions than do exporters. The average value that farmers give to each factor is 3.5, whereas that figure is 3.1 for exporters. The two only factors that exporters consider more important than farmers do are the need for lower prices for rail transport and for road transport to be more expensive. However, the differences between the mean values for the two groups are not statistically significant. Hence, it cannot be argued that other factors are more important for exporters than they are for farmers.

The respondents were then asked to prioritize three of the 15 factors that, from their point of view, are most crucial to increasing the use of rail-based intermodal transport. A total of 130 priorities were indicated by the respondents. In contrast to the ranking presented in Table 4, in which all factors could be assessed as important, the prioritization illustrated in Figure 2 forced the respondents to state which factors they considered most vital. The factors in Figure 2 are ranked according to the total number of priorities.

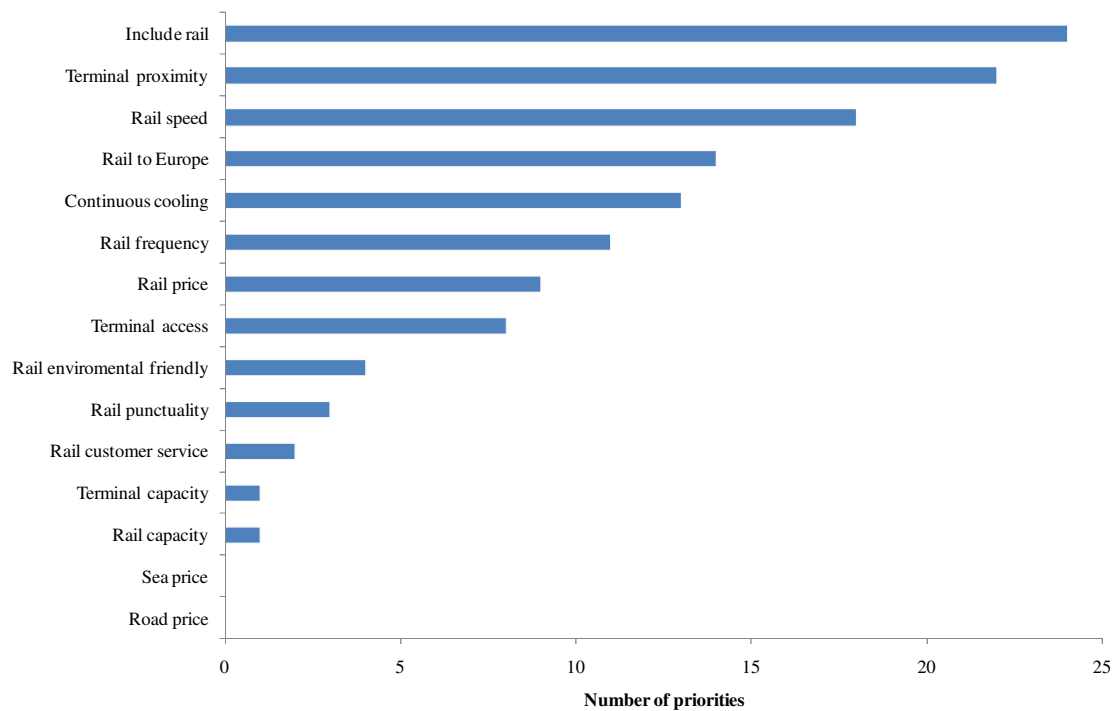


Figure 2: Prioritization of the most important factors to promote the use of rail-based intermodal transport of fresh fish from Norway to Continental Europe.

It is evident from Figure 2 that the most important factor in facilitating the rail-based intermodal transport of aquaculture products from processor to consumer is that service offerings including rail must be expanded. At the time the survey was conducted, there were virtually no cross-border transport solutions for fresh products including rail transport, and none offered long-haul rail transport all the way to a central hub in Europe, which is ranked as the fourth most prioritized characteristic. The second most important factor is that terminals must be located in close proximity to fish processors. The third most important factor is rail speed. Other characteristics of the rail and terminal services are assessed as less important.

The prioritization of factors in Figure 2 largely corresponds with the ranking of the mean values in Table 4. That is, the amount of intermodal transport solutions including rail must be increased, and they must run all the way to a hub in Continental Europe in a continuous (unbroken) thermo chain. Moreover, the aquaculture industry states that capacity on the rails and in the terminals are currently not a problem and that increasing the price of other transport modes is not a desirable way to make rail-based transport solutions more attractive.

## 5. Conclusions and Policy Implications

The substantial external costs associated with freight transport on the road are both due to it being a major source of pollution and an important contributor to congestion on the road network. As a result, it has become European policy on both the regional and

the national level to shift freight from the road to other transport modes like rail and boat.

The most critical factor in achieving sustainable transport is the successful promotion of intermodal transport. Given the limited success of previously implemented policies related to perishable goods, the need for additional knowledge regarding how to increase the use of intermodal transport becomes obvious. This article identifies the factors that must be addressed to make the intermodal transport of perishable products from Northern to Southern European countries more attractive. The export of fresh fish from Norway to Continental Europe is used as an example, but the findings are also relevant to intermodal transport for other categories of perishable goods.

The analysis is based on a survey of 113 managers in the Norwegian aquaculture industry. The industry states that if policymakers want to alter the mode of transport chosen for aquaculture products, they should primarily aim their attention at exporters. If the aim is to influence route choice decisions, however, the preferences of transporters are equally important to address.

It is most critical that intermodal transport solutions including rail service be increased and that these routes run all the way to a hub in Continental Europe in a continuous (unbroken) thermo chain. The challenge of creating an unbroken thermo chain across countries could be approached via equipment standardization. Other obstacles to developing such intermodal services include creating a better balanced flow of goods from north to south and sufficiently large volumes.

The problem of unbalanced flow has to do with the need for the refrigerated containers used to transport fish southbound to Continental Europe to be filled with other commodities that require cooling when they return northbound to Norway. This will increase overall capacity utilization so that the rail-based transport solution becomes competitive with respect to price and simultaneously remains profitable for operators. Currently, imports to Norway that require cooling, such as fruit and vegetables, are transported primarily by road, though they are also transported by sea.

The scattered structure of the Norwegian aquaculture industry poses a challenge to the establishment of sufficiently high volumes. There are many relatively small companies that do not individually produce sufficiently large quantities to make rail-based transport solutions practical. Today, these companies procure transport services separately for their own production. However, the total export of aquaculture products is sufficiently large to fill trains so that they can depart at a satisfactory frequency. Hence, if the industry can cooperate in procuring transport services, they will be able to achieve intermodal transport solutions involving long-haul transport to Continental Europe by rail. This requires a commitment among purchasers of transport solutions to providing predetermined volumes of commodities or establishing of dedicated "rail ports" for freight of goods to and from Norway. However, the structural changes that are currently taking place within the industry, encouraging the creation of fewer and larger companies, is paving the way for such agreements because fewer companies need to coordinate.

The respondents from the aquaculture industry also point out the need for investments in the intermodal terminals where their products are loaded onto the trains. Although current capacity is considered acceptable, there is a need to reduce the transport barriers separating farmers from the terminals. This can be achieved by establishing terminals closer to processors and by improving the road network so that the terminals will become more easily accessible. Such investments require public subsidies, possibly in

cooperation with companies within the logistics chain for aquaculture products if they find it sufficiently attractive. In addition to the positive effects of a general upgrade in infrastructure via such investments, the main argument for public financing is that it reduces the external cost of transport (e.g., it is more environmentally friendly, causes fewer accidents and decreases congestion on the roads).

Most of the characteristics of long-haul transport by rail that are singled out as important relate to the time sensitive nature of deliveries of perishable goods. Higher frequency will reduce waiting time and, as previously mentioned, can be improved if processors commit to delivering sufficiently large volumes at certain deadlines. Moreover, the punctuality of trains, which has been a problem on the Norwegian railway network, although most prominent for passenger transport, must be at an acceptable level. The expected transport time will be further reduced by investments in centralized traffic control (CTC), double tracks or side crossings and increased prioritization of freight trains. Further research could reveal how the policy actions to make intermodal transport more attractive relate to supply chains for different types of products.

Facilitating intermodal transport by implementing policies based on the factors identified in this study will require political will and improved competitiveness for intermodal transport of perishable goods will not be achieved unless policymakers invest in and prioritize rail transport. Moreover, by addressing these factors, European politicians will reduce the external cost of transport, improve European integration by reducing export barriers and support the rural regions of Europe that often rely on the production and sale of perishable agricultural products.

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