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REORIENT

Implementation of Change in European Railway System

Deliverable D6.1, Version 1.0

Demand And Supply Structures For Intermodal (Rail-Based) And Single Modal (All Truck) Freight Supply Solutions

REORIENT WP 6

Deliverable D6.1 Draft Version 1.0

Demand and supply structures for intermodal (rail-based) and single modal (all truck) freight supply solutions

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DEM	Demis B.V.	NL
DLR	Deutschen Zentrum für Luft-um-Raumfahrt	D
TOI	Institute of Transport Economics	NOR
NU	Napier University	UK
UOB	University of Bologna	IT
UMD	University of Maryland	USA

Preface

REORIENT is a Coordination Action funded by the European Commission within the Sixth Framework Programme that addresses Strategic Objective 3.3.1 "Research to Support the European Transport Policy, Research Domain 3.1, Implementation of Change in the European Railway Area". The REORIENT project is examining the effects of the EU's legislation on rail interoperability, which is transforming the European rail freight industry from closed, monopolistic, nationally-oriented businesses insulated from market realities into market players where newcomers both from the rail and logistics industry can find new opportunities, and from non-interoperable nationally-fragmented railway subsystems into an internationally integrated pan-European system.

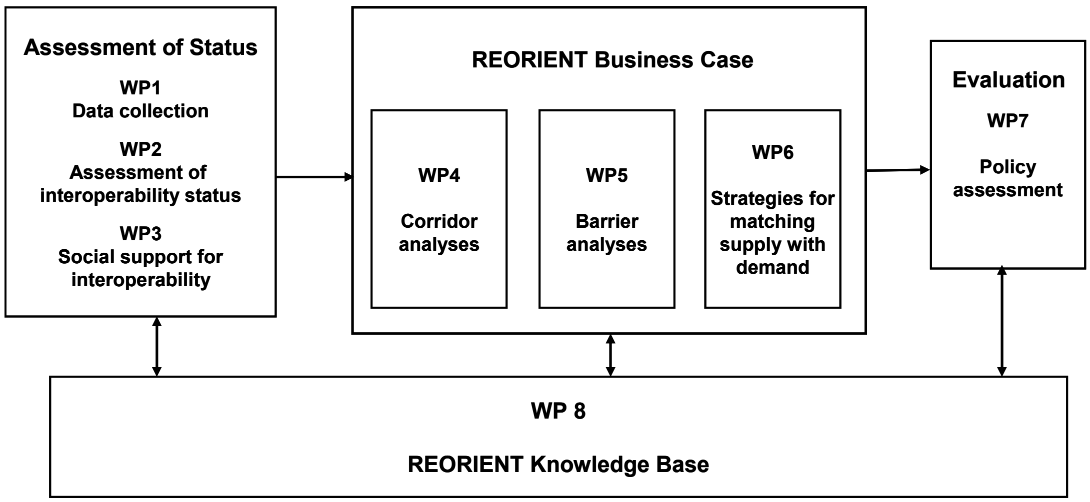
From a research perspective, these massive changes pose a host of challenges in monitoring and understanding how common legislation is transposed under diverse national political and economic conditions, industry changes, and social support and opposition to the changes. From a global perspective, these changes are taking place in the midst of a serious transformation of the transport industry as a whole, and where old solutions rapidly are becoming obsolete.

The project is focusing on a trans-European transport corridor through eleven countries (called the REORIENT Corridor) stretching from Scandinavia in the north to Greece in the south, and is working toward three main objectives:

1. Assessing and monitoring the progress toward the development of an integrated freight railway system in the countries located along the REORIENT Corridor, explaining the variation in the status of interoperability across these countries, assessing the degree of political and social support for improving interoperability in these countries, identifying barriers to seamless rail freight transport through these countries, and recommending ways to overcome the barriers.
2. Identifying and assessing the market potential for new international rail freight transport services through these countries.
3. Evaluating the relevant internal and external effects that will result from implementing the new services, including the effects on rail companies and shippers, and the effects that bear on the whole society and the environment.

As shown in the figure below, the technical part of the project is divided into eight work packages, which are grouped into three sets, roughly corresponding to the three main objectives specified above (although much of the work in Work Package 5 is related to the first main objective). This report documents the work performed in Work Package 6 (WP6) – an examination of demand and supply structures for intermodal (rail-based) and single modal (all truck) freight supply solutions, which addresses the second of REORIENT's main objectives.

The results from this work will be used by WP4, WP5, and WP6 in identifying new rail services that might shift freight from road transport to rail-based transport.



This report has been prepared by the REORIENT Consortium, which consists of seven partners and sixteen subcontractors, representing research institutes, private companies, rail organizations, and universities in fourteen European countries and the United States. WP6 has been led by TOI, the Norwegian Institute of Transport Economics (Oslo, Norway).

For more information about this document, please contact:

Johanna Ludvigsen
TOI
P.O. Box 6110 Etterstad
N-0602 Oslo, Norway
+47-22 573 844

Further information about the REORIENT project is available on the project's Website: https://www.reorient.org.uk/ .

Executive Summary

Abstract

An overall objective of the REORIENT project is to develop a business case for a new rail service between the Nordic countries and countries in Central- and South Eastern Europe. We developed, conducted, and used information from a survey conducted by the REORIENT project among intermodal freight shippers in countries within the REORIENT Corridor to identify essential factors for attracting freight from the road-to-rail-based services and we performed in-depth analysis of shippers' quality requirements. Based on official statistics for trade and freight flows in the corridor and knowledge of the current transport services in the corridor, we found there is potential for new rail services in the corridor to attract a considerable amount of freight from road to rail-based conveyance. We specify a set of new rail services for the corridor in which these quality factors are embedded. This report also includes a description of mode choice models that were developed to analyse shippers' propensity to change their mode of transport. We present the determinants we identified for shifts from truck-only to rail-based transport solutions.

Introduction

The European Commission's unit, Rail Transport and Interoperability within DGTREN, financed research as part of FP6 to gain knowledge of the current markets for alternative transport solutions, the mechanisms and driving forces behind growth in the markets and to be able to stimulate provision of competitive rail based intermodal transport solutions.

The objective of Work Package 6 (Quality Standards Underlying Modal Choices) is to (1) identify quality factors that determine shippers transport service choices, (2) propose new rail services for the REORIENT Corridor, and (3) propose business and management models that can be organised for new rail-based transport within the business environment.

This report describes a shipper survey of customer's quality requirements that we conducted to identify factors that are important in order to attract freight from road to rail-based services and to enable us to carry out an in-depth analysis of shippers' transport quality requirements. Determinants for modal shift are also identified. Official statistics are used to identify the economic importance of the Corridor and characteristics of overall freight flows. Based on the official statistics, we indicate the potential of new rail services in the Corridor to attract freight from road, We suggest new rail services for the Corridor assuming the quality factors identified as important for attracting freight from road to rail-based transport solutions are embedded.

Identification of factors that are essential for attracting freight from road to rail-based transport

High growth in typical truck-only commodities and a decline in traditional rail commodities is an important reason why the share of truck transport has become larger. This marks considerable up-market shift from bulk haulage where rail used to compete with low-value high-volume sea-going cargo. But because of the emergence of the intermodal industry, the rail services have gradually captured a part of the market segment that was served by truck transport.

To identify the market for rail-based[1] intermodal transport solutions and important quality factors for attracting freight from road to rail-based transport solutions, we developed a survey instrument[2] and carried out a survey to collect representative information about shippers' shipments in the market for intermodal transport services that have their origin and/or destination within the REORIENT Corridor.

Six research institutes with good knowledge of transportation and logistics industries in twelve European countries[3] identified and used the instrument to make interviews with companies in the market for intermodal transport services.

The survey polled 246 business respondents: 140 were manufacturers and/or merchandisers performing import and export shipments, while 106 were forwarders and/or logistics service providers (LSPs) who served international freight flows. Both groups of informants are referred to as "shippers" in this report. A majority (52%) of the companies were big (yearly turnover > €50 million). Decision scenarios for routes of 425 typical shipments were obtained. Out of these, 332 were classified as single modal transfer and 93 as intermodal transfer. 70% of the total number of shipments in the survey were carried out by truck-only, but truck-only carried only 37% of the total volume (in tonnes). Of the 425 shipments, 383 were performed by land-based transport of truck-only and rail-based transport.solutions. Most of the shipments are executed on a daily or weekly basis.

The rail routes identified from the survey show that almost all the shippers surveyed use TEN-T axes for rail-based consignments. This indicates that shipments in our study move along the Trans-European Transport Network (TEN-T) to which the European Commission (DG TREN) assigns great socio-political value and which will receive considerable European and national investments over 2007-2013.

[1] For REORIENT, we classified possible transport chains as (1) truck only, (2) rail-based, and (3) other modes of conveyance, where the first is only road, rail-based is any transport chain where rail is used on at least one leg and the third comprises combinations of boat, inland waterway, airborne transport, pipeline, etc. but no rail.

[2] Based on a data collection technique devised by Evers, Harper and Needham (1996) "The Determinants of Shippers Perception of Modes", *Transportation Journal* ,Vol. 36, No.2, pp 13-25, and adapted for use in the European context by Ludvigsen (1999).

[3] Austria, Bulgaria, Czech Republic, Finland, Greece, Lithuania, Norway, Poland, Romania, Hungary, Slovak Republic, Sweden

Load carrying units used by shippers in the survey sample
From the WP6 shippers survey, we found that semi-trailer carried by truck-only is the dominant transport solution within the market for intermodal transport solutions. This is consistent with statistics for the situation in the Czech Republic that show container transport increased and heavy goods vehicles on rail declined to zero between 2003 and 2005[4]. Whereas containers are only carried by rail, we found that swap bodies are carried by both rail and truck.

However, from the survey sample we find that about 90% of LCUs moved by truck could be forwarded in tanks, semi-trailers, swap-bodies and containers on *rail flatcars*. And the types of LCUs used signify existing intermodal competition between road and rail conveyance. The swap-body is the primary LCU used for freight dispatched by both single-modal and intermodal truck-based transport operations. Traditional full wagon loads (FWL) accounted for just 40% of volumes carried by rail. This indicates that about 60% of freight carried by rail in the market for intermodal transport services is conveyed in intermodal transport units, such as 20 and 40-feet containers (1 and 2 TEU) and swap-bodies.

From the survey sample we found an under-usage of load carrying capacity in rail cars, semi-trailers, and 40 feet containers. This can be due to voluminous goods with low unit weights may or inability to stow more goods in each transport container due to time pressure for shipment expedition.

Manifestation types and rail versus truck-only transport
The total volume of the typical land-based shipment from the shipper survey was 35 thousand tonnes. From the survey sample we found percentage shares by manifestation types[5] of: General cargo (66%), liquid-bulk (3%), semi-bulk (16%), dry-bulk (12%), vehicles (3%), and crude oil (0%). For comparison the percentage shares by manifestation type based on data from ETIS-Base for of the total export/import flows within and between regions in the REORIENT Corridor were: General cargo (20%), liquid-bulk (13%), semi-bulk (21%), dry-bulk (34%), vehicles (0%) and crude oil (11%). This high percentage of general cargo in the survey sample becomes even more dominant in value.

The general cargo manifestation is primarily composed of manufactured products. Out of the 252 general cargo shipments 22, 7, 38, 58, 68 and 59 were in the SITC-1 categories 0,1,5,6,7 and 8[6], respectively. Semi-bulk is also an important commodity

[4] Though semi-trailer on rail flatcar is still in use and is considered as an attractive business in other European corridors, e.g., CargoNet collaborates with DB rail on a rail service for semi-trailers on flat cars from Gothenburg to Duisburg. CargoNet is currently experiencing considerable growth in volumes carried and presumes that this trend will continue.

[5] Manifestation types are commodity groups that are used in ETIS-Base, which is an information system of integrated policy tools to support policy analysis and policy making (http://www.iccr-international.org/etis/).

[6] SITC 0: Food and Live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 3: Mineral fuels, lubricants and related materials, SITC 4: Animal and vegetable oils, fats and waxes, SITC 5: Chemicals and related products SITC 6:Manufactures goods classified chiefly by material, SITC 7:Machinery and transport equipment, SITC 8:Miscellaneous manufactured articles, SITC 9: Commodities and transactions not classifed elsewhere in the SITC

type, which has overall lower value than the general cargo category (out of 63 semi-bulk shipments in the survey, 55 were in the SITC-6 category).

From the total yearly volumes based on shipper's frequency of overland shipments and the number of shipments by truck and rail registered, approximately 85% of the general cargo volumes were carried by rail (in tonnes). The percentage is much higher than in the total general cargo flows (about 50-50) based on ETIS-Base. The reason is due to the target group of our survey, which was primarily shippers that are already making decisions between uni- versus intermodal consignment. We also prioritised big shippers in order to cover as much as possible of the market for intermodal transport solutions. Thus our sample covered to a lesser extent a considerable number of shippers who are still not considering rail-based intermodal transport.

Contestable markets for rail and road

By SITC classification of the survey sample, we found that machinery/transport equipment (SITC-7) accounted for 25% of tonnage moved by truck, but the survey sample contains no shipment of this commodity group by rail. On the other hand, manufactured goods accounted for 80% and 48% of freight carried by rail and truck, respectively, which more specifically indicates that a rail-road competitive interface exists in this market segment. Chemicals represented another commodity category where rail and road compete for the same type of shippers, with respectively 7% and 2% of volumes carried by each mode (the rest is carried by other modes - mostly seaborne transport solutions). Foodstuff and beverages represented another market segment with road-rail rivalry, which, however, was dominated by trucks carrying 17% of tonnage registered against 2% conveyed by rail. About nine percent of crude materials and fuels were carried by rail, but only for 3% by truck. From the WP6.1 survey we also find that intermodal transport by rail where rail haulage is combined with freight consolidation and/or bulk-breaking operations performed by truck at both ends are small (only 4% of tonnage forwarded by shippers surveyed).

Analyses of characteristics of rail and road users reveal that 59% of the volumes by rail were shipped by the medium-size shippers who forwarded the largest volumes by rail, and only 37% by the biggest ones. The small companies with a relatively small rail share were under-represented in our survey. (We found that only 4% of the volume by rail were shipped by shippers with turnover > €10 million.) The tonne share of shipments by truck-only versus rail-based solution of big, medium and small shippers were 47, 67, and 12 percent.

From the survey, we found prices paid by shippers per unit ton of freight carried in rail wagons and semi-trailers on routes selected. Rail obtains about 60% lower prices than truck for transfer of technical and finished products. The price paid for transport foodstuff and chemical by rail and truck are at the same level. So why are the numerous small shippers not making use of rail transport for their numerous small shipments?

The number of rail-based versus truck-only general cargo shipments was 207 (78%) for truck-only and 45 (18%) for rail-based transport. Based on the *reported frequency* of each shipment in the representative sample, we find that about 80% of general cargo shipments are by truck (70% for the total sample) and 20% by rail-based solution. But overall for the sample and in particular for the general cargo segment, we find that sizes of truck and rail loadings differ significantly. For truck the mean weight of general cargo shipment is 18 tonnes, whereas for rail it is 346, which explains why rail based transport dominates in terms of tonnes.

This finding has implications for rail and rail-intermodal operators. They should target medium-size manufacturing companies and LSPs for access to stable, large and growing markets for freight services where the rail-based alternative currently constitute a considerable market share. These businesses may have positive experience from usage of rail freight. Therefore, they may harbour greater propensity for extended usage of rail, provided important service quality requirements are fulfilled.

Barriers hindering the numerous small shippers from using rail-based transport are:

1. Small shippers have less bargaining power to obtain low prices and other satisfactory qualities of rail-based transport
2. The rail network is less dense than road network
3. Rail services are not feasible unless shippers invest or lease in new and appropriate LCUs and equipment for drayage
4. Greater truck-only share in value than in tonne for the general cargo commodity indicates that general cargo shipped by truck-only transport has higher value than the type of general cargo shipped by rail-based transport. Thus a reason for the relatively high truck-only shares of shipments shipped by small shippers can be that some elements of transport quality are not acceptable for the general cargo composite shipped by small shippers - regardless of price and the level in other quality dimensions (i.e., below critical levels).

Shippers' transport quality requirements

For the typical shipments the survey questionnaire included a section in which the shipper was asked to rank the importance and satisfaction of 23 transport quality dimensions. For the truck shipments, the reliability of supply and the cost of service were the quality dimensions for which we found the most significant deviation between importance and satisfaction. The rail users were most dissatisfied with poor availability of rail service at the shipments' origins and (poor) value for money paid for freight transfer. Reliability of freight delivery, quality of processing of loss and damage, transit time and information promptness on cargo under shipment and after arrival all scored low on shippers' satisfaction with rail services supplied. Yet, rail operators scored better than road on environmental friendliness, and availability of LCUs suitable for shipment size and types of commodity carried. All in all, rail scored higher on five qualities delivered as compared to shippers' expectations. For truck, the number was seven.

From the survey it was found, however, that the ranking of the importance of quality factors for shipments that were carried out by truck and rail were different. Shippers' importance and satisfaction with quality requirements varied more for rail than for truck. And, by and large, participants in the study were less satisfied with services supplied by rail than by truck.

This shows, however, that the level of quality is still above the critical level, and although there is less dissatisfaction with truck-only transport we found that shippers benefit from low unit prices for shipment by rail.

Identifying underlying dimensions of transport quality by factor analysis

For analysis of the importance of transport quality dimensions and the shippers' actual choices of road and rail, we used regression analysis with independent variables to classify shippers and commodities and to represent qualitative and quantitative quality characteristics. We found that the 23 qualitative model variables explained 60 percent of variance in the overall importance that European shippers' assigned to *rail* service quality on routes used. For road the regression model explained 35 percent of variance in the overall importance assigned by European shippers to service quality on truck routes.

Based on factor analysis, we found important *underlying quality dimensions that* we interpreted as "*Dealing with Service Failures*", "*Intermodal Expediency*", "*Efficiency of Cargo Intake and Discharge"*. For rail *Intermodal Expedience was the only significant factor.* Significant single variables include shipments of foodstuffs and shipments by companies with revenues exceeding 10 million Euros. Consignments of full wagon loads and tank wagons, although significant were not considered important for the shippers' assessments of overall service quality. This is understandable given the fact that wagon loads constitute traditional rail service which usually operates in single-modal fashion. A positive and highly significant impact of Intermodal Expedience is attached to shippers whose service quality is more important for high-value foodstuff. For *truck* four of the five factors extracted from the data significantly contributed (Service availability, dealing with service failures, technical efficiency, and value for money). The relatively low percentage of variance explained and the high level of error term indicate that variables other than those in the equation exert causal impacts on shippers' choices of transport by truck. These variables may be related to cargo specifics shipped and/or to national features of truck service markets in the countries surveyed. Still another explanation could be that important determinants of truck service selection were excluded from our survey instrument, and thus could not be tested by the above model.

Transit time

Transit time is one of the highly ranked quality dimensions and the the quality dimension with the greatest relative deviation between importance and satisfaction. By regression analysis, we found that route kilometres in transit by the different modes are, not unexpectedly, the strongest determinants for duration of transit time[7].

Model parameters (constant, rail km in Eastern Europe, rail km in Western Europe, sea transit distance, length of route, number of border crossings, among others) explained 74 percent of variance in time of door-to-door freight transport by road. However, the negative and significant coefficient values on three dummy variables: *service with daily frequency*, *shipments of chemicals* and *consignments with origins located in west-Europe* reveal there are types of shipments that are moved significantly faster. The model explains 64% of the variance in duration of freight transport by rail. Rail transit time increases with distances of sea crossings, overland haulage, and border crossings into and inside Eastern Europe. The model indicates also that larger shippers manage to reduce transit time for their consignments and that haulage by rail included in intermodal freight transfer shortens shipments' overall travel time. This may happen because large shippers possess efficient service procurement departments who ship large and regular consignments, and their shipments are prioritized by service providers who manage to produce competitive advantage from rail line-haul within intermodal supply.

Market conditions for new and improved rail services in the REORIENT Corridor

Early in the project, the geographical scope of REORIENT was narrowed to a corridor for freight transport between the Nordic countries and Central- and South-Eastern Europe. The corridor covers 11 countries[8].

Seaborne transport between ports in the Nordic countries and in Poland is needed for connection of the northern and southern part of the corridor. North of the Baltic Sea is a well developed network of rail shuttle services to economic centres in the Nordic region. To the south, there are currently primarily conventional rail services.

Of the Polish ports, only the port of Gdynia has an intermodal terminal. But, although there are no facilities for handling intermodal units in Swinoujscie, we have information that sea-rail connections can be established in several ways. Currently, the port of Ystad is the only one with a ferry connection to Swinoujscie, but a new Ro-Ro and train ferry operation is planned between Trelleborg and Swinoujscie from late 2007. The intermodal terminal in Gdynia is the most important Polish port for transport between Finland and Poland, and Finland ship 55% of all tonnes of general cargo (60% in value) from the Nordic countries. Gdynia also attracts freight via shipping lines from Sweden and Norway. Based on Eurostat and Polish port statistics[9] for the year 2004, we found that the general cargo share of total port turnover in Gdynia is 64%, and only 4.5%, 16%, and 11% in Swinoujscie, Szczecin, and Gdansk.

[7] Distance is inevitably an important determinant, which we didn't ask for in the shippers survey because it is easily assessed by GIS. The regression models on the dependent variable "transit time" assessed how this factor was affected by transport distance and the features of shipment corridors in different countries and regions.
[8] Norway, Sweden, Finland, Poland, Austria, Czech Republic, Slovak Republic, Hungary, Romania, Bulgaria and Greece.

[9] To obtain numbers specifically for the %-age of general cargo we used information on internet sites for the respective ports: http://www.phs.com.pl, http://www.bulkcargo.com.pl/ang/statistics/cargo.htm, http://www.port.gdansk.pl, http://www.port.gdynia.pl.

The economic importance of the REORIENT Corridor

Statistics from the World Trade Organisation (WTO) and data for year 2000 from ETIS-Base show that the REORIENT countries trade with the EU25 member states varies between 86% and 53% of their total trade. Trade with Germany and Italy is important. The REORIENT countries' trade with other REORIENT countries varies between 12.9% and 4.3% of their total trade, indicating significant economic importance. Intra-corridor trade is greatest for countries located in central parts of the corridor [10].

Imbalances of directional freight flow between REORIENT countries

The directional imbalances of overall freight flows may affect capacity utilization and therefore the economy of round trips for the rail-based services. Both the magnitude and the structure of trade in the REORIENT Corridor is relevant for capacity utilisation and the profitability of new rail freight services.

ETIS-Base shows that the southbound and the northbound tonne volumes flowing between the Nordic region and the other REORIENT Corridor countries are balanced. In value, however, the northbound flow is 36 percent smaller. Tonnage balance but imbalance in value is explained by the different composition of, and the different density of, the flows traded.

A total flow of 3.7 million tonnes is shipped southbound and 1.1 northbound between the Nordic countries and South-Eastern Europe - a deficit of 60% in northbound flows in tonnes and the same deficiency in value.

In more detail we find for Finland that the import is 2.8 million tonnes and the export only 1.3 million tonnes in trade with other REORIENT countries (except Norway/Sweden), where the coal from Poland to Finland contributes to the deficit[11]. This balances out overall for the Nordic countries as the opposite is found for Norway/Sweden.

The value of goods exported to Norway and Sweden is higher than the value of goods imported from Norway and Sweden. Also, Bulgaria/Romania/Hungary has a relatively big surplus in tonnes in trade with Greece that levels out in value. Trade between Bulgaria/Romania/Hungary and Austria/Czech/Slovakia is balanced in both value and tonnes. Bulgaria/Romania/Hungary has a deficit in trade with Poland that also levels out in value. Transport volumes grow rapidly in both directions

[10] Total merchandise import (cif) and export (fob) and EU-25 trade were obtained from WTO (http://stat.wto.org) and were used together with ETIS-Base 2000 freight flows to assess the share of total trade that takes place within the REORIENT Corridor. Approximate 2005 levels of export and import within the corridor were based on ETIS-Base for year 2000 and projected growth in the baseline SCENES scenario 1995-2025.

[11] This is a one-way transport that has declined in recent years. The biggest Finnish export flows in the REORIENT context are to Austria and Czech Republic, where Finland exports paper and steel-based products. Imports are mainly metal and steel.

From the PolCorridor LOGCHAIN Project (2006) we have that the total transport demand (in tonnes) between the Nordic countries and South-Eastern Europe increased over 1999-2002 by 18 percent. The corresponding growth in cargo relevant for rail-based intermodal transport was 21 percent in Southbound direction and 24 percent in Northbound direction over 1999-2002, which helped to compress the direction imbalance. If this development continues, it will over time increase the conditions for proper capacity utilization and the profitability of operating new rail services in the corridor.

Corridor choice of current freight flows

From the shippers survey carried out in REORIENT and survey work in earlier research projects (Scandient, PolCorridor, LogChain) we found that goods shipped between some of the REORIENT countries often transit over Germany despite the scarcity of infrastructure capacity or other through route choices. A reason is that services through Germany are still preferred, which is to some extent explained by low investments in the REORIENT Corridor, resulting in insufficient transport quality for certain goods types. From ETIS-Base, we found that only about 17 percent of the transshipped freight flows between the Nordic countries and South-Eastern Europe are shipped through Poland.

Rail shares between REORIENT countries and with the hinterland

Overall, we find from official statistics that the share of international freight volumes carried by rail-based solutions varies considerably geographically. This is due both to differences in the types of commodities carried and differences in available transport services. We have relatively high rail-based share between Central- and South-Eastern Europe (57%), between Central-Europe and Western-Europe (43%), and between South-Eastern Europe and Western Europe (12%), Freight shares between the Nordic region and other regions in the REORIENT Corridor are generally lower than between the Nordic region and Western Europe. An exception is northbound freight volume, from Central Europe to the Nordic region, which contains big amounts of coal from Poland to Finland.

Several direct shuttle services are running in the east-west direction, whereas in the REORIENT Corridor such services are not established yet[12]. This can in part explain the differences in the rail shares.

New rail services in the REORIENT Corridor

Taken together, the economic importance of the REORIENT Corridor, the recent trend toward greater growth in the northbound direction, the current route choices of freight flows between REORIENT countries, and the fact that a proper rail service is missing in the REORIENT Corridor, indicate that it is possible that a new rail service could attract

[12] Political exclusion of Central and Southeast Europe from the mainstream of western European integration until the early 1990s caused that the majority of freight currently flowing between the Nordic region and the Central and South Eastern Europe still transits via the Swedish-German intermodal corridor linking Trelleborg with Rostock and Munich).

considerable amount of freight from road to rail-based solutions in the REORIENT Corridor.

Improvements needed for attracting freight from road to rail
To increase the share of rail-based transport, new rail services for the REORIENT Corridor should be suited to both:

- Medium to big companies and Logistic Service Providers (LSPs) for access to stable and large goods repositories
- Companies with smaller and not as frequent shipments that today use truck-only transport

For the Medium-big companies one should:

1. Improve important quality factors and make prices competitive
2. Involve more LSPs in managing the medium and small shipments

More active collaboration between railway companies and LSPs could improve service where rail haulage is combined with freight consolidation and/or bulk-breaking operations at both ends. Competitive prices for such services could stimulate small companies to outsource their shipments to LSPs that use rail-based services.

An important finding was, however, that of today's LCUs carried by truck, 90% can be carried on flatcars (tanks, semi-trailers, swap-bodies and containers on *rail flatcars*). Thus, to alleviate barriers hindering small shippers from using rail based transport, it is necessary to:

1. Reduce the entry costs by providing flat cars for semi-trailers
2. Improve critical and important quality factors
3. Provide rail-based consolidation/bulk breaking logistic services

The REORIENT service concept
Based on statistical and professional knowledge of the current freight flows between REORIENT countries, we have proposed to establish shuttle trains travelling non-stop between terminals:

(1) Swinoujscie (Poland)-Bratislava/Vienna
(2) Gdansk/Gdynia-Bratislava/Vienna-Budapest-Thessalonica
(3) Bratislava-Budapest-Constantia

Moreover, based on the quality factors found important to attract freight shipped by big, medium, and small shippers, we suggest that the services on these itineraries should be:

(1) *Swinoujscie-Bratislava/Vienna*: Full Container Load (FCL) block train connecting dedicated to movement of paper rolls.
(2) *Trelleborg-Swinoujscie-Bratislava/Vienna*: Semi-trailer, Swap body on Flat Car (SFC), and full container load (FCL) shuttle train customised to needs of 3 PL and 4 PL Losgistic Service Providers who buy roundtrips.
(3) *Gdansk/Gdynia-Bratislava/Vienna-Budapest-Beograd-Thessalonica*: Mixed Container on Flat Car (CFC) and SFC shuttle train connecting
(4) *Bratislava-Budapest-Bucharest-Constantia:* Mixed CFC/SFC shuttle train and/or FCL (for unitised bulk). *This service will compete with existing service from Rotterdam.*

Shippers mode choice based on transport quality
The ranking of 23 quality factors and results from analysis of underlying quality factors gave substantial input to the development of models for assessing changes in shippers' mode choice with respect to changes in transport quality.

Ideally such models should take into account the causal decision process behind freight mode choices, where a mode isn't an option if certain transport quality requirements aren't satisfied; e.g., for fresh degradable food, a minimum commercial speed and a minimum temperature is required. We may take this into account by simply using an infinitely low utility for modes that do not satisfy the minimum requirements. On the other hand, as long as we use aggregate commodity groups that consist of commodities with different minimum requirements, we either get a biased model (if we set the minimum to the least demanding commodity within the group) or a model where the mode is unavailable to a part of the commodities despite the minimum requirement being satisfied (e.g., if the average minimum requirement for the commodity group is chosen). Consequently, for the REORIENT work we decided not to make an explicit representation of minimum requirements.

We used two approaches for the development and estimation of mode choice models based on the multimodal logit model structure. In the first approach, we analysed the overall effect on mode shift. We slightly modified the original logit model structure and estimated mode specific models by logistic regression. Odds-ratio measures were used to analyse the models' ability to predict mode shift of rail versus truck with respect to changes in the transport speed. As an example, the effect of improved speed of rail freight movement increases the probability of choosing rail for supply of the main SITC categories, semi-finished products (SITC 6) and machinery/technical equipment (SITC 7), whilst other cargo categories are not significantly affected. A one-point rise in satisfaction with reliability of rail service achieved the highest odds of mode change. The results indicate that considerable mode shifts are possible in regions/corridors with potentials for higher service reliability. This is a reasonable result because, by and large, rail is still cheaper than truck as regards transfer of some processed commodities, provided of course that rail could meet other related requirements.

The second approach was to develop a model to be integrated with the REORIENT network model for assessment of mode choice at the shipper level. The NST/R 11 commodity classification is used, but because of the scarcity of data for some of the commodity groups, we decided to try a functional relationship with several common parameter values for all commodity groups. For the functional relationship we didn't see any reason to deviate from linearity with regard to the parameters. A special imputation technique based on information of overall mode shares of total flows from ETIS-Base, commonly referred to in the literature as instrumental variables or 2SLS estimates was used to replace missing survey data for mode alternatives not chosen by respondents and missing elements of transport quality for the chosen mode. We used only variables for shipper's characteristics and level of service data. We didn't include variables corresponding to the qualitative information from the WP6.1 survey, since there is no corresponding variable in the network model. Maximum likelihood was used for simultaneous estimation of common, mode specific, and commodity specific variables.

Conclusions

From in-depth analysis of data from the REORIENT shipper survey, we found that (1) Rail shipments are big and primarily shipped by big shippers, (2) The numerous small shippers has a relatively low rail share, (3) Manufactured goods (general cargo) is the major commodity group in the market for intermodal services, (4) Rail-based transport is cheaper than truck for the major commodity groups. Based on official statistics primarily from ETIS-Base, foreign trade statistics, and projections in growth of the demand for transport between corridor countries of commodity groups relevant for rail-based transport, we found there is potential for new rail services in the REORIENT Corridor to attract considerable amount of freight from road to rail-based conveyance.

For medium to big companies we identified that improvements to attract more freight from road to rail would be to improve highly ranked quality factors with significant gaps between shippers ranking of importance and current satisfaction with the services. It is still important to ensure competitive prices. To broaden rail-based services competitive interface with truck-only transport, the service quality needs to be improved sufficiently enough that rail-based transport becomes an alternative mode for carriage of the numerous small shipments for small shippers that today are primarily carried by road-only transport. Essential in this regard are the Logistic Service Providers as a link for the consolidation and bulk-breaking. Their presence and effective and efficient performance are necessary for cost effective distribution of small shipments.

The value of goods conveyed by truck is overall of greater value than goods conveyed by rail-based transport solutions. For rail to broaden its market also to segments that today are primarily served by truck-only transport, it is important to increase transport quality especially in dimensions where there is a large discrepancy between the importance and satisfaction with transport quality and where the current quality standard on rail-based solutions is below critical levels for rail to be a possible alternative to road-only transport.

Two approaches to mode choice analysis based on random utility theory identified that shippers mode choice decision is significantly sensitive to reliability, transit time and speed, and that the sensitivity depends on type of commodity, and length and duration of shipments. For travel time it is a large discrepancy between importance and satisfaction for shipments by rail-based transport. As a consequence we found that a unit increase in transit time affects rail more negatively than truck, and thus greater probability for rail than for truck that an increase in transit time leads to transport quality below the critical level where the mode isn't an alternative any more.

By improving the service quality it could also be possible for rail-based solutions to compete more fiercely directly in the market for shipments of single LCUs. Three types of LCUs dominate rail transit in the countries analyzed: 20 and 40 feet containers, and swap-bodies. This indicates that rail may capitalize on its inherent competitive advantage in door-to-door segments and intermodal chains. Semi-trailers on flat cars is also a potential market if a sufficient rail service is established. We have imbedded the identified factors for attracting freight from road to rail-based solutions in a set of suggested rail shuttle services in the REORIENT Corridor.

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Contents

1. INTRODUCTION

The REORIENT project is examining the process of transforming the European railways from non-interoperable nationally fragmented railway subsystems into an internationally integrated pan-European system as a consequence of the EC interoperability legislation. By so doing, it is supporting the EU policy of balancing modal split between road and rail freight transport. It is doing this by focusing on a transport corridor through eleven countries (called the REORIENT Corridor) stretching from Scandinavia to Greece (Figure 1.1), and working toward four major objectives:

1. Assessing and monitoring the progress toward the development of an integrated freight railway system in the countries located along the REORIENT Corridor, explaining the variation in the status of interoperability across these countries, assessing the degree of political and social support for improving interoperability in these countries, identifying barriers to seamless rail freight transport through these countries, and recommending ways to overcome the barriers.
2. Identifying and assessing the market potential for new international rail freight transport services through these countries.
3. Develop new business concepts for trans-European rail freight transport that will make rail conveyance more competitive than truck.
4. Evaluating the relevant internal and external effects that will result from implementing the new services, including the effects on rail companies and shippers, and the effects that bear on the whole society and the environment.

Work Package 6 (WP6) is focused on the second of these objectives. The objective of WP6 is to identify the existing market for international intermodal transport solutions, and to analyse how operators' business and management models of rail based transport can be organised within the REORIENT Corridor business environment in order to attract freight from road and competing corridors.

This deliverable (D6.1) is the first out of two deliverables from the WP6 work. It focuses on a survey carried out among customers in the market for rail based intermodal services whose objective was to identify the most important factors for attracting freight from road to rail-based transport and to perform an in-depth analysis of shippers' quality requirements. A combination of survey data and data for total flows are used to identify characteristics of the market for intermodal services. We scope the competitive interfaces with truck and the market specific transport quality requirements that affect shipper's mode choice in this segment. We use official statistics to indicate, from the perspective of trade between countries located in the corridor and the total transport flows between REORIENT countries and between REORIENT countries and the hinterland, the potential of new rail services to attract freight from road to rail-based services. Based on the identified quality factors, we describe what would be important elements of new rail services, and we specify a set of new rail services for the corridor in which these quality factors are imbedded. Development and analyses of models for shippers' mode choice are described.

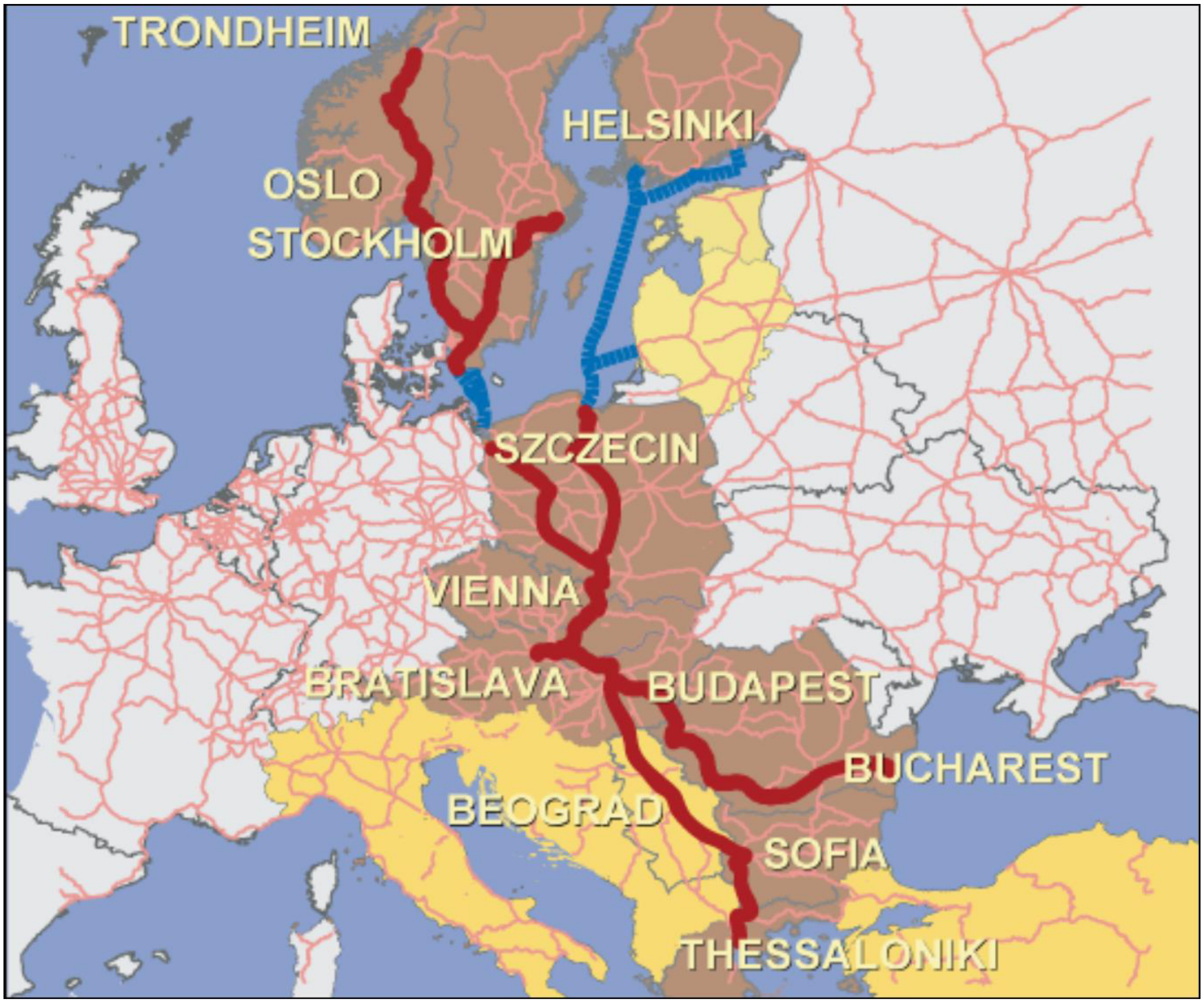

Figure 1.1: REORIENT Corridor and itineraries of the REORIENT service concept.

1.1. Purpose

D6.1 covers work performed as part of tasks WP6.1, WP6.2 and WP6.3, and covers fulfilment of the following three milestones:

- M6.1 Major quality barriers for rail-based intermodal transport.
- M6.2 Market segments for single- and intermodal freight movement solutions and the most important market players.
- M6.3 Quality improvement needs/strategies and quality standards for international supply of seamless rail services.

The milestones reflect the needs to fulfil the WP6 objective in terms of contextual empirical knowledge to identify the freight market in the REORIENT Corridor and the transport quality standards required for shipment of different commodity groups, the current and potential competitive interfaces between unimodal and intermodal transport solutions and what quality dimensions are the most critical in order to make intermodal transport solutions successful in competing with unimodal transport solutions.

The main purpose of this report is to describe how we fulfilled the WP6 sub-objective of identifying existing markets for international intermodal transport, essential factors for attracting freight from road to rail-based solutions, shipper's quality requirements, and improvements needed to attract freight from road to rail. The report also describes the empirical and analytical work that was carried out to establish statistical and mathematical models needed for the analysis of how customers' transport quality requirements and changes in the quality of the transport services provided affect mode choice decisions.

1.2. Background

Overall growth and structural changes affects trade and thereby changing demand for international transport services. According to the White paper "…growth is to a large extent due to changes in the European economy and its system of production. In the last twenty years, we have moved from a "stock" economy to a "flow" economy. This phenomenon has been emphasised by the relocation of some industries - particularly for goods with a high labour input - which are trying to reduce production costs, even though the production site is hundreds or even thousands of kilometres away from the final assembly plant or away from users. The abolition of frontiers within the Community has resulted in the establishment of a "just-in-time" or "revolving stock" production system".

It is evident from transport statistics that the changes have an impact on the overall growth in the transport work and an increase in the share of international freight transport versus domestic freight transport. Hence social and business issues related to international freight transport in Europe is becoming steadily more important

The importance of mode selection decisions stems from two political concerns. The first is the need to stop the growth of environmental externalities associated with wide-spread use of motor carriers for international freight movement. The other arises from the need for empirically verified knowledge of factors detrimental to use of environmentally friendlier freight carriage such as rail-based intermodal and single-modal transport for transfer of goods in European corridors.

According to the Commission's White Paper "European Transport Policy for 2010 : Time to decide", the Commission's aim is to use an integrated package of measures to limit the expected 50% increase of heavy goods road traffic alone between 1998 and 2010 to 38% by improving the performance of the alternatives to road transport - short sea shipping, rail and inland waterway. Actions will hence focus on supporting alternatives to road transport, particularly for the "long haul" section of journeys. This not only reduces congestion, but improves road safety and is good for the environment.

The European Commission is taking action to increase the share of international rail-based freight transport versus road. Directives are issued by the Commission for implementation in the EU member countries in order to help reduce the current barriers to help the strengthening of the intra-modal and extra-modal competition versus road transport. The Commission also organises and coordinates a number of public institutions in possession of responsibility for advisory services and control of the European transport systems. Additionally the Commission finances important research and development to continually acquire knowledge of, and means for how, the markets for international freight services could make broader use of rail-based intermodal transport solutions.

The European Commission's unit, Rail Transport of and Interoperability DGTREN, financed research as part of FP6 to gain knowledge of the current markets for alternative transport solutions, the mechanisms and driving forces behind growth in the markets, and to be able to stimulate provision of competitive rail based intermodal transport solutions. REORIENT was one consortium that was granted financial support from the Commission.

The objective of Work package 6 is to identify the existing market for international intermodal transport solutions, to identify essential factors for how to attract freight from road to rail and to analyse how operators business and management models of rail based transport can be organised within the business environment of a trans-European corridor in order to attract freight from road and competing corridors.

In terms of policy relevance, the research sought hard facts on the structure of supply and demand for freight carriage that the European Commission may use for making infrastructure decisions and/or design policy instruments that will enhance market attractiveness of rail freight dispatch.

1.3. Document structure

Chapter 2 describes the design of a survey instrument for collecting data of shippers business activity and shipment routes for their typical shipments. We present data obtained by carrying out the survey in 12 corridor countries. Competitive interfaces between truck-only and rail-based transport solutions are identified, and we explain how data were used to identify barriers that hinder bigger volume shares on rail-based transport solutions.

For the typical shipments the survey questionnaire included a section where the shipper was asked to rank the importance and satisfaction of 23 transport quality dimensions. In chapter 3 we present results from analyses of shippers ranking of quality dimensions and factor analysis of the quality dimensions underlying "desired level of service quality". We present results from in-depth analyses of the effect on transit time of marginal increases of distances in different part of the transport network.

Chapter 4 contains extracts of data from official statistical sources for economic importance of the REORIENT Corridor and characteristics of corridor freight flows, which are used to assess and discuss the potential that new rail services in the REORIENT Corridor could attract considerable amounts of freight from road to rail based transport solutions.

Identified improvements needed for attracting freight from road to rail are presented in chapter 5. We conclude the chapter by a description of the REORIENT service concept which is designed to take into account the improvements we found necessary to attract freight from road to rail.

Chapter 6 describes two approaches for development and analyses with the model for shippers' choice of transport solution based on transport quality requirements. Missing data represents challenges to how existing methods can be used to exploit the WP6.1 data. The first approach solves the problem by aggregating the share of freight shipped by each mode and consider only effects of isolated changes in transport quality per mode. The model is used for analysis of the expected sensitivity of mode shift with respect to changes in transport quality. The main purpose of the second approach was to establish a model that can be used within the REORIENT network model for predicting mode shares between pairs of geographical zones at disaggregate level (i.e., per shipper). An imputation method is used to replace missing data. Parameter estimates and associated elasticities are presented and discussed.

Conclusions are provided in Chapter 7.

Appendix A provides a brief description of intermodal transport in the REORIENT Corridor, Appendix B presents a segmentation of the typical survey shipments by SITC commodity groups and ETIS manifestation type, and Appendix C briefly explains the contents of ETIS-Base, which was used as the main source of data for total freight flows

2. SURVEY SAMPLE OF CUSTOMERS IN THE MARKET FOR INTERMODAL RAIL-BASED SERVICES

To analyze specifically the market for intermodal freight services we found it necessary to obtain a combination of hard facts and attitudinal data for recording revealed preferences for transport qualities harbored by the actual decision makers.

From earlier research there were no European studies that properly covered this subject. Therefore, WP6 made the first attempt to collect data on Nordic, Central, and Southeastern shippers who use rail and road for freight conveyance and systematically analyze the structure of service supply and demand in these two European regions. In this chapter we describe the survey instrument developed for this purpose, how the empirical data obtained were used (1) to explore the supply and demand structure for intermodal transport and (2) to identify and rank factors of transport quality, and (3) to develop and analyse statistical models for shippers mode choice decisions based on quality factors of available transport solutions.

2.1. Shipper survey instrument

Development of the survey instrument was initially based on a data collection technique devised by Evers, Harper and Needham (1996) that complies well with this definition and was used to assess “The Determinants of Shippers Perception of Modes”. This instrument is a questionnaire that was adapted for use in the European context by Ludvigsen (1999), whose study captured revealed preferences for transport quality of Nordic shippers. Subsequently, the instrument was amended in 2003 for survey trials in Norway, Hungary, Lithuania, and Sweden under the Eureka ∑ 2727 PolCorridor project, and was slightly developed to fit the needs of the REORIENT project.

A criterion was used for collection of the WP6.1 shipper survey sample such that it contains a representative sample of responses from shippers in the REORIENT countries that are representative of the market for intermodal transport services. As part of the survey questionnaire, shippers are asked for shippers’ typical shipments in the market for intermodal transport services that has origin and/or destination in the REORIENT Corridor.

The first part of the instrument was used to gather information on shippers’ business characteristics. The general questions regard whether the shipper is a forwarder, a logistic company, or a manufacturing company. The turnover is asked for and whether the company is an exporter/importer or both. There are also questions about how frequently the company uses different single mode and intermodal services and how many LCUs they own and rent.

The second part was used for collecting information about decision scenarios, where shippers assigned two regularly used consignments (exports and/or imports) to transport solutions offered by operators of international corridor(s). The decision scenarios contain one qualitative and one quantitative part. For the quantitative part the shippers were asked for examples of typical shipments and specifically the shipment route utilised for the typical shipments (2 per company. For companies that are both importers and exporters we asked for one import and one expert route). The shipper was asked to specify characteristics of the typical shipments in terms of (1) commodity type, (2) weight of shipment (tons), (3) volume of shipment (cubic metres), (4) whether the load is classified as hazardous material (yes/no), (5) Estimated value of the goods in shipment (€), (6) How frequently the shipment is carried out (daily/weekly/monthly/un-frequently), (7) type of load carrying unit (LCU) used on the route, and (8) number of load carrying units per shipment. Moreover, questions were asked to quantify quality factors of the chosen transport solution for each typical shipment in terms of:

(1) The lead time (h), i.e., the total door-to-door transit time.

(2) Total price for one way delivery (€).

(3) Deadline for booking (no. of hours before departure).

(4) The extent to which the customer have access to tracking & tracing (multiple choice).

(5) % of yearly shipments delayed on this route.

(6) % of yearly shipment with loss/damage of goods on this route.

(7) Although not asked for in the questionnaire, GIS tools made it possible to determine the distance between origin and destination of the shipment.

(8) Time use (no. of hours) in transfer points (harbour time, border time, storage time, terminal time).

The qualitative part was set up to acquire response to assess the shippers' ranking of 23 quality dimensions (importance) and the actual quality obtained (satisfaction) on the example routes.

The survey instrument complies well with the definition from the European Commission's Directive on "Intermodality and Intermodal Freight Transport in the European Union" [COM (97) 243/4], where intermodality is defined as "a characteristic of a transport system that allows at least two different modes to be used in an integrated manner in door-to-door transport chain". This description actually allows the transfer of unit load devices to be interrupted by opening the load carrying units at intermediate points within an overall journey, for partial break-bulk at freight handling stations.

2.2. Survey scope and the sample acquired

Guidelines defined the survey target group to be important manufacturing and merchandising industries that are large exporters and importers of important products. Because many manufacturing and merchandising companies outsource their physical distribution, it was also advised to include large logistical firms who serve import/export flows, to obtain a representative sample of shippers.

Data were collected in 2005 by six research institutes with good knowledge of transportation and logistics industries in twelve European countries. They identified and used the instrument to make interviews with companies in the market for intermodal transport services.

Data collectors identified the target companies and obtained consent from companies' management for participation in survey. Subsequently, they queried the transport professionals (dispatchers) in the companies surveyed, who procured transport services and assigned freight shipments to international transport paths. These professionals provided the actual data.

The initial thought was to limit the survey sample to companies that are currently using intermodal transport solutions, i.e., to a representative sample of shippers that ship with rail-based intermodal solutions and make choices between non-intermodal and intermodal solutions. However, data collection revealed very early that intermodal freight services are not yet well developed in several European countries, and that very few shippers could be identified that used both types of conveyance. Particularly, this prerequisite could not be fulfilled by all shippers operating in Slovakia, Hungary, Poland, and Romania, where we obtained interviews also with shippers that currently make exclusive use of road-only transport solutions.

In contrast to the stated preference method, which is often solely used to assess the transport users' espoused quality preferences, our survey design reveals the actual preferences. The respondents specify the duration of door-to-door transit, price for one-way freight carriage, frequency of shipments, and all types of modes used under consignment transfer. Next, informants evaluate twenty three quality dimensions of transport solutions used for shipments of a given cargo, and then the overall quality standards on each route. Service quality on the routes selected was evaluated by two measures. The first was "importance" that a given informant assigned to each of the twenty three quality-attributes before a consignment was expedited. The second appraised "satisfaction", which the informants attributed to the same twenty three quality dimensions after a consignment had been delivered.

From the survey, we achieved substantial information about the shippers' business characteristics in terms of the (1) types of load carrying units used, (2) utilization of different types of LCUs, (3) commodities shipped, (4) prices for shipments per unit tones per *rail wagons* and *semi-trailers*, (5) typical shipment characteristics and geographical localization of transport routes, and (6) ranking of importance and satisfaction of quality factors of shipments by road and rail.

The survey polled 246 business respondents; 140 were manufacturers and/or merchandisers performing import and export shipments, while 106 were Logistics Service Providers (LSPs) who served international freight flows (Table 2.1). Both groups of informants are referred to as "shippers" in this report. Figure 2.1 shows the sample distribution among large, medium and small firms.

Table 2.1: Firms in survey

Country of Location	Forwarders and/or Logistic Suppliers	Manufacturers and/or Merchandisers
Austria	3	27
Bulgaria	7	2
Czech Republic	7	16
Finland	4	22
Greece	7	3
Lithuania	27	0
Norway	9	8
Poland	24	15
Romania	6	0
Hungary	5	5
Slovak Republic	6	23
Sweden	1	19
Total	106	140

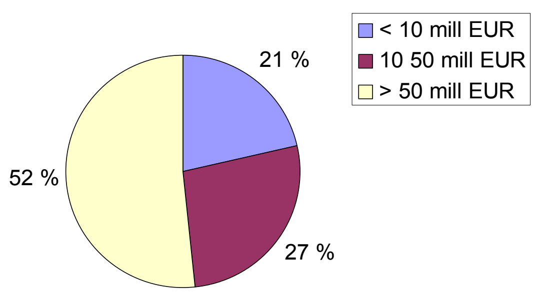

Figure 2.1: Shares of big, medium, and small companies in the shipper survey sample.

The number of intermodal freight lanes registered in the survey confirms the dominance of single-modal freight carriage for the European mainland. It also reveals high dependence of Nordic countries as well as Lithuania on sea links in the Baltic Sea for transshipments to and from the European mainland.

Out of the total survey sample, we identified 425 shipments. Decision scenarios for a total of 383 land-based shipments were obtained (i.e., routes with only a minor part of the transport by seaborne transport). Cases from the sample are shipments within the corridor, but a substantial share originates in or destined for hinterland countries. From the survey we found that most of the shipments are executed on a daily or weekly basis.

Rail routes identified from the survey show that almost all shippers surveyed use TEN-Taxes for rail-based consignments (Figure 2.2). This indicates (1) that shipments in our study move along the Trans-European Transport Network to which the European Commission, DG TREN assigns great socio-political value and which will receive considerable European and national investments over 2007-2013, and (2) that shipments in our study represent typical freight consignments moved along the existing European transport routes.

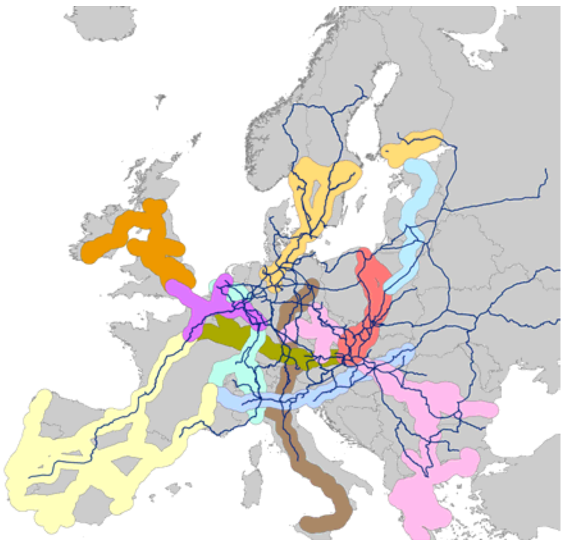

Figure 2.2: Routes for typical railway shipment from the shipper survey (blue curves) and TEN-T intermodal priority axes (colors)

The following map shows the road routes in Europe used by shippers surveyed for freight transfer and delivery (Figure 2.3).

Figure 2.3: Map of routes for typical road shipments from the shipper survey

2.3. Load carrying units used by shippers in the survey sample

From the WP6 shippers survey we found that semi-trailer carried by truck-only is the dominant transport method within the market for intermodal transport solutions. This complies with the situation in the Czech Republic, where statistics from container transport increased and whereas heavy goods vehicles on rail declined to zero between 2003 and 2005[13]. Whereas containers are only carried by rail we found that swap bodies are carried by both rail and truck.

From the survey sample we find that about 90% of LCUs tonnage that today is carried by truck could be forwarded in tanks, semi-trailers, swap-bodies and containers on rail flatcars (Figure 2.4). The types of LCUs used signify existing intermodal competition between road and rail conveyance. Swap-bodies is the primer LCU used for freight dispatched by both single-modal and intermodal truck-based supply. Traditional full wagon loads (FWL) accounted for just somewhat below 40% of volumes carried by rail. This indicates that about 60% of freight carried by rail in the market for intermodal transport services is conveyed in intermodal transport units like 20 and 40-feet containers (1 and 2 TEU) and swap-bodies.

[13] Though semi-trailer on rail flatcar is still in use and is considered as an attractive business in other European corridors, e.g., CargoNet collaborate with DB rail on a rail service for semi-trailers on flat cars from Gothenburg to Duisburg. CargoNet is currently experiencing considerable growth in volumes carried and presumes that this trend will continue.

The respondents to the shipper survey had to specify modes of the transport chain in terms of (1) Transport mode when leaving origin, (2) transport mode when arriving at destination and (3) any other transport mode used on the route. We find from the survey sample that trans-European cargo transfer by single-modal transport solutions involve a maximum of two operators, while the intermodal transport chains involve one, two or three transport carriers who serve shipments between origins and destinations (Table 2.2). Common for both forms of freight transfer is that different operators function in a highly synchronized manner in order to deliver consignments on-time and breakage-free.

The collaboration between truck and rail operators involves transfer of containers, swap-bodies and semi-trailers on rail flatcars (TOFC) as well as bulk-breaking at intermodal terminals and/or freight service stations. Similarly, working relationships between railways and short-sea and/or deep-sea shipping lines consists in transfer of containers on flatcars (COFC), or supply of vessel-rail service combination for port-to-port freight transfer and/or between harbors and inland destinations. Collaboration between rail-ship-truck operators involves sea-land bridging for terminal-port and port-to-door rail freight supply.

Table 2.2: Intermodal and single-modal transport solutions on survey routes

Single-modal Transfer	Number of Shipments/Lanes	Intermodal Transfer	Number of Shipments/Lanes
Truck	219	Truck + RoRo**	19
Truck + RoRo*	62	Truck + Rail	29
Rail	48	Truck + Ship	32
Rail + Rail Ferry	3	Rail + Ship	3
		Truck+ RoRo+ Rail	4
		Rail+Ship+Truck	6
Sum	332		93

**Although on the face this form of freight dispatch involves two modes, it was defined as single-modal because it pertained to shipments involving Nordic countries and/or England. Geographical location in these countries requires that all trucks need to cross the sea en route to Continental Europe. Therefore, RoRo ferries are considered here as a part of road infrastructure for sea crossing.*
*** This freight dispatch category included un-accompanied load carrying units (LCUs) such as semi-trailers and/or swap bodies which although carried by truck to a Ro-Ro quay may optionally be carried by truck or rail after arrival at port of discharge.*

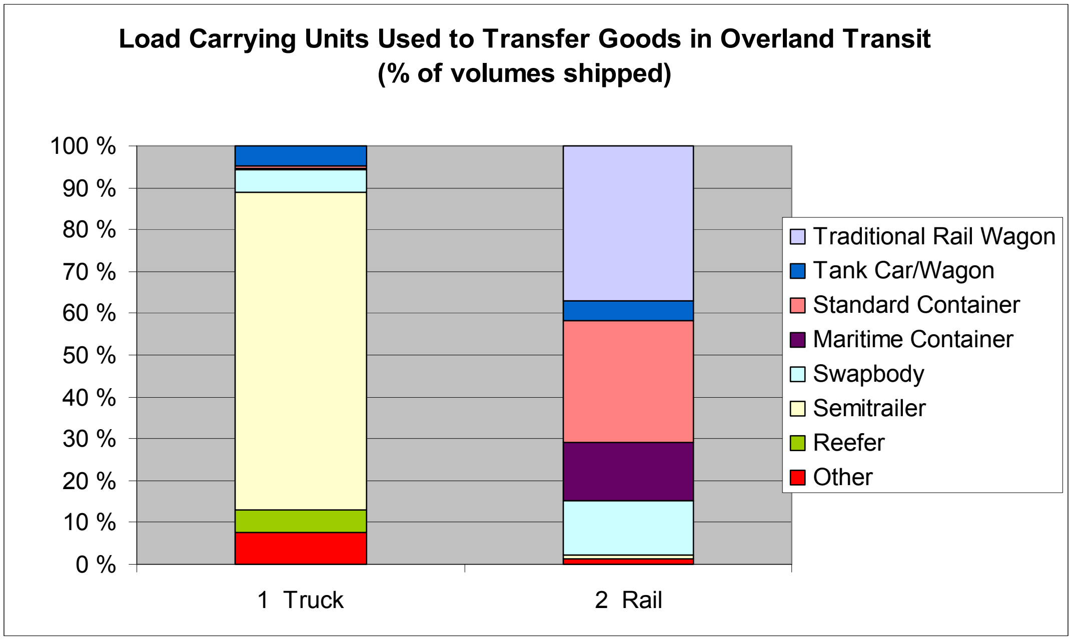

Figure 2.4: The share of types of load carrying units (LCUs) used by shippers surveyed for dispatch of freight volumes.

It is noticed that carriage of voluminous goods with low unit weights in rail cars, semi-trailers and 40 feet containers may explain under-usage of load carrying capacity (Table 2.3). Another explanation could be inability to stow more goods into each transport box due to time pressure for shipments expedition.

Table 2.3: Freight volumes shipped by different types of LCU (Tons)

Type of LCU	Mean	Std. Deviation	Minimum	Maximum	Median
Rail Wagon	36	19	6	80	35
Tank Car	34	14	8	60	30
20”Container	15	4	12	25	15
40”	21	6	5	24	20
Swap Body	19	7	10	33	18
Semi-trailer	18	9	0	72	20
Reefer	18	6	5	22	20

2.4. Manifestation types and rail versus truck-only transport

ETIS-Base classifies freight flows according to manifestation type[14]. Shipments within the same manifestation type are similar with regard to the way the goods are manifested and hence may indicate what handling and transport solutions are suitable. To investigate the share of different manifestation types in total freight flows within the REORIENT Corridor and in the market for intermodal transport solutions, we segmented by manifestation types the data from ETIS-Base for the total freight flows within the REORIENT Corridor and the shipments from the shipper's survey sample. The share of General cargo dominates and is much greater in the survey sample and becomes even more dominant in value (Table 2.4).

Table 2.4 Percentage international freight flows (by tonne) by type of manifestation (value in parentheses)

	Shipper survey	ETIS flows
General cargo	66	20 (73)
Liquid bulk	3	13 (5)
Semi bulk	16	21 (13)
Dry bulk	12	34 (4)
Vehicles	3	0 (4)
Crude oil	0	11 (1)

There is certainly a share of the total flows by ETIS general cargo manifestation type that is not suitable for long distance rail-based transport (e.g., very time sensitive freight), where primarily air-borne transport is used. These flows are small relative to the total flows in this segment, however. Thus, from the great share of survey responses in the ETIS general cargo manifestation type, we do overall consider the total ETIS flows of general cargo as representative and within the market for intermodal transport solutions.

Out of 252 general cargo shipments, 22, 7, 38, 58, 68 and 59 were in the SITC-1 categories 0, 1, 5, 6, 7, and 8[15]. Semi-bulk is also an important commodity type which has overall lower value than the general cargo category (out of 63 semi-bulk shipments in the survey 55 were in the SITC-6 category "Manufactures goods classified chiefly by material"). By values the percentage distribution of the total flows are changing to: General cargo (73%), liquid-bulk (5%), semi-bulk (13%), dry-bulk (4%), vehicles (4%) and crude oil (1%). Especially general cargo becomes much greater because of its high

[14] Information about ETIS-Base is provided in Appendix C.

[15] SITC 0: Food and Live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 3: Mineral fuels, lubricants and related materials, SITC 4: Animal and vegetable oils, fats and waxes, SITC 5: Chemicals and related products, SITC 6:Manufactures goods classified chiefly by material
SITC 7:Machinery and transport equipment,SITC 8:Miscellaneous manufactured articles, SITC 9: Commodities and transactions not classifed elsewhere in the SITC. (see also Appendix II)

value. This verifies that the high value products and thus cargo items that tend to require high transport quality are in the general cargo segment and thus in the market for intermodal services.

From the total yearly volumes based on shipper's frequency of overland shipments and the number of shipments by truck and rail registered, approximately 85% of the general cargo volumes were carried by rail (in tonnes) (Figure 2.5). The percentage is much higher than in the total general cargo flows (about 50-50) based on data from ETIS-Base. The reason is that a considerable number of shippers are still not even considering intermodal transport, whereas our sample was specifically targeted at shippers that are currently using intermodal transport solutions.

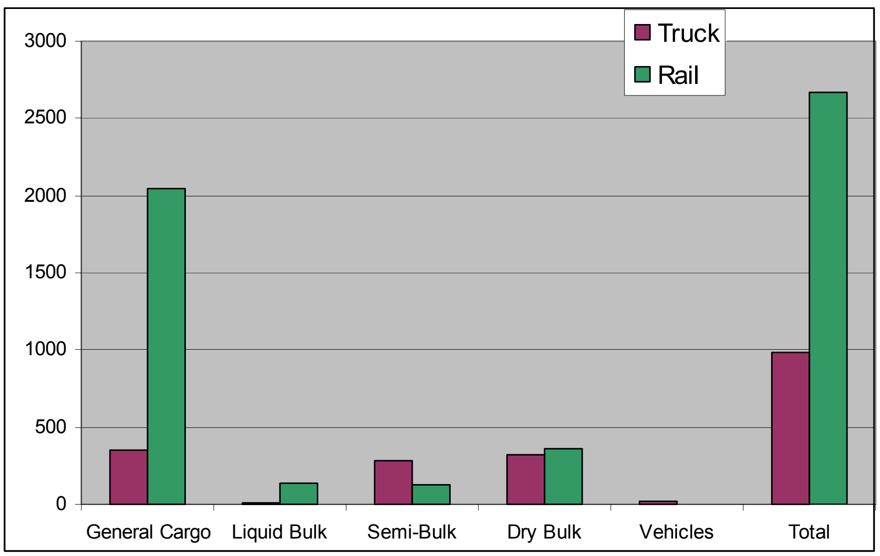

Figure 2.5: Total yearly shipment volumes on truck and rail by shippers in the WP6.1 shippers' survey. By main cargo group (1000 tonnes)

2.5. Contestable markets for rail and road

High growth in typical truck commodities and a decline in traditional rail freight share explain why the volume of truck transport has grown. This marks considerable up-market shift from bulk haulage where rail used to compete with low-value high-volume sea-going cargo. Consequently, the overall shippers' transport quality requirements have grown. Therefore, the traditional rail service quality standards do not represent a competitive alternative to road-based transport.

The markets for rail and truck services are visualised in terms of individual shippers probability to select truck-only versus rail-based transport solutions (Figure 2.6). Freight market is composed of three segments, rail-only shipments, rail versus truck and truck only. Some shippers are only considering either rail or truck. They have probabilities of zero and one, respectively, for selecting rail-only or truck-only transport solution for their shipments. However, due to the new block train concept and the emergence of the intermodal industry[16], the rail services have gradually achieved a market share for transport of commodities that are part of market segments where truck transport has a strong position. Thus a market has emerged where rail-based solutions and truck-only solutions are in a competitive interface. This is a market segment where shippers have a probability between zero and one of selecting truck-only versus rail-based solution.

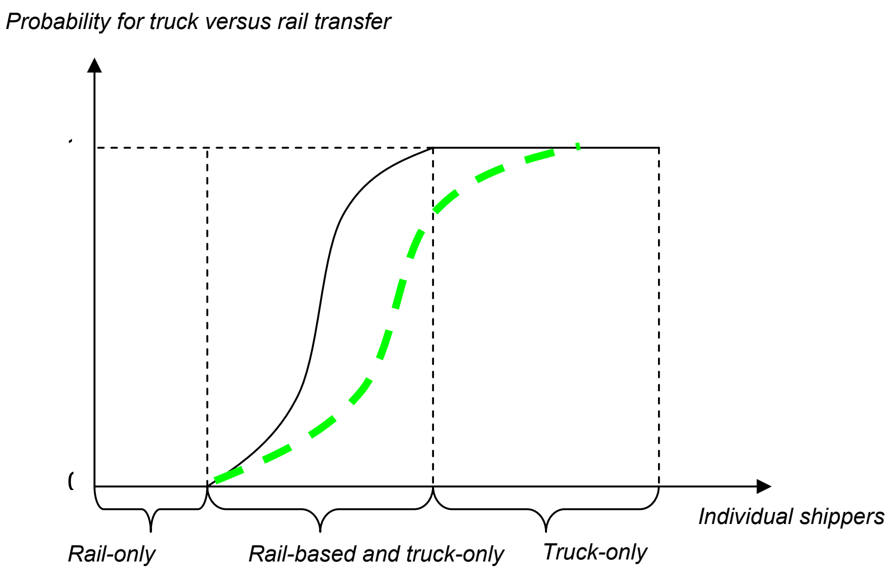

Figure 2.6. Schematic view of individual shippers' probability of selecting rail-based versus truck-only transfer.

Figure 2.7 reveals that rail and road compete in several markets for freight transfer. Competition interfaces, albeit of different size and intensity, could be identified in transfer of four freight categories. By SITC classification of the survey sample we found that machinery/transport equipment (SITC-7) accounted for 23% of tonnage moved by truck, but the survey sample contains only a few shipment of this commodity group by rail. On the other hand, manufactured goods accounted 80% and 48% of freight carried by rail and truck, respectively, which more specifically indicates that rail-road competitive interface exists in this market segment. Chemicals represented another commodity category where rail and road compete for the same type of shippers, with respectively 7 and 2% of volumes carried by each mode (the rest is carried by other

[16] According to Woxenius and Bärthel (2002) emergence of the intermodal industry developed when the container was introduced in the shipping industry during the 1960's. The national railway companies founded container transport companies in order to offer complementing land transport. Intercontainer (now Intercontainer-Interfrigo, ICF) was founded for international transport and companies like Transfracht in Germany and Compagnie Nouvelle de Cadres (CNC) in France were founded for domestic transport. ICF and the national container companies have their base in the transport of maritime containers to and from seaports, but they also offer transport of containers, swap bodies and to some extent also semi-trailers between European inland terminals.

modes - mostly seaborne transport solutions). Foodstuff and beverages represented another market segment with road-rail rivalry, which, however, was dominated by truck carrying 17% of tonnage registered against 2% conveyed by rail. About nine percent of crude materials and fuels were carried by rail, but only for 3% by truck.

A share of intermodal transport units carried by rail does also include the trans-European logistical chains where rail haulage is combined with freight consolidation and/or bulk-breaking operations performed by truck at both ends. Although the market segment for such intermodal transit is small (only 4% of tonnage forwarded by shippers surveyed), it may quickly rise if the quality of rail service is improved.

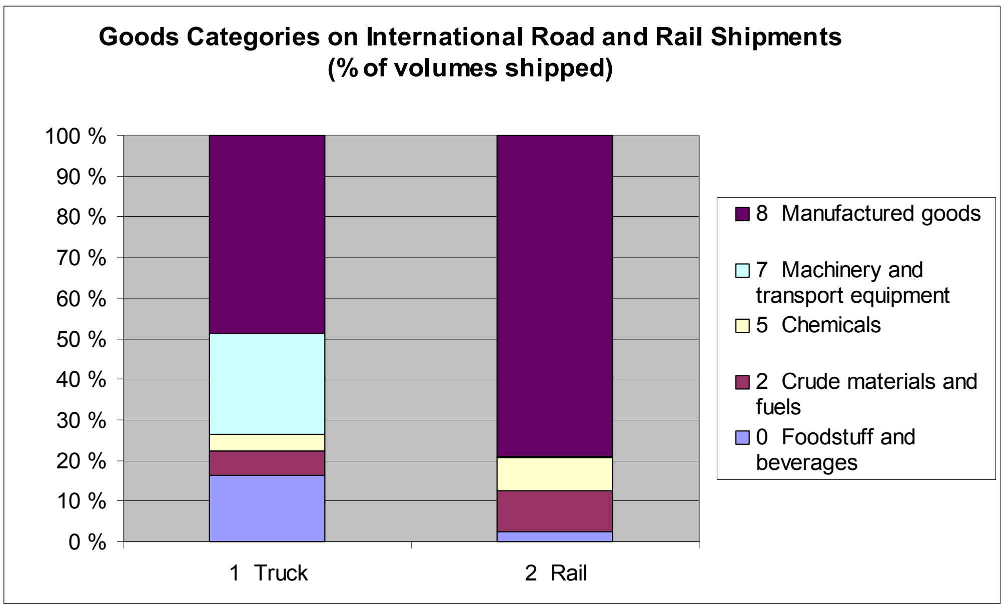

Figure 2.7: Percentage distribution of commodity categories on truck and rail conveyance in the sample of shipments of the REORIENT shipper survey.

Table 2.5: Commodity categories in shipments registered

Commodity Categories in Figure no 4	**Denomination in Terms of SITC Main Chapters**
Manufactured goods	SITC6 + SITC8
Machinery and transport equipment	SITC7
Chemicals	SITC5
Crude materials and fuels	SITC2 + SITC3
Foodstuff and beverages	SITC0 + SITC1

Out of these 332 were classified as single modal transfer and 93 as intermodal transfer. 70% of the total number of shipments in the survey was carried out by truck-only, but truck-only carried only 37% of the total volume (in tonnes). Aanalyses of characteristics of rail and road users reveal that 59% of the volumes by rail were shipped by the medium-size shippers who forwarded the largest volumes by rail, and only 37% by the biggest ones (Figure 2.8). The small companies with a relatively small rail share were under-represented in our survey (We found that only 4% of the volume by rail were shipped by shippers with turnover > €10 million). The tonne share of shipments by truck-only versus rail-based solution of big, medium, and small shippers were 47, 67, and 12 percent,

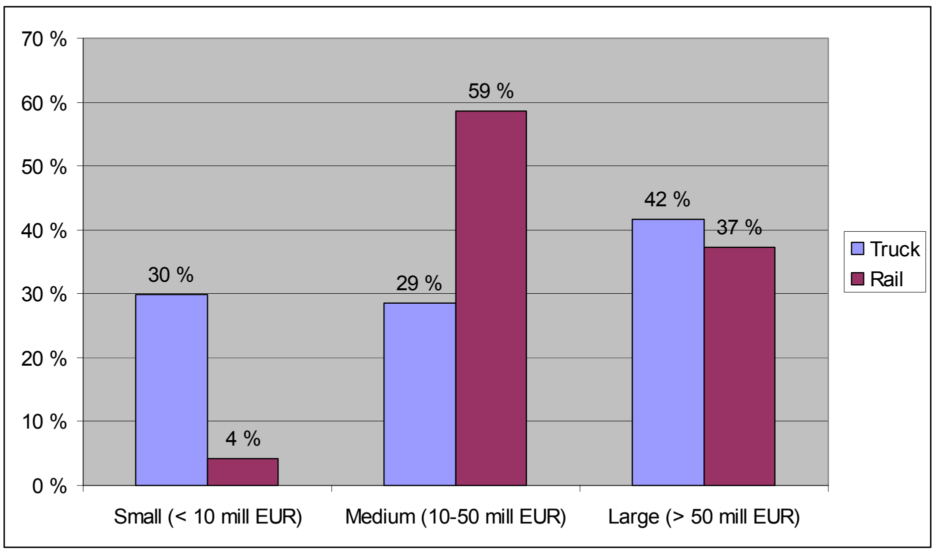

Figure.2.8: Road and rail shipments weighted by freight volumes shipped yearly

From the typical shipments of the shippers survey, we derived the Euro prices paid by shippers for unit ton of freight carried in rail wagons and semi-trailers on routes selected for different SITC commodity groups (Table 2.6). Of the markets we identified as competitive interfaces (i.e., “Manufactured goods”, “Chemicals”, “Foodstuff and beverages”, and “Crude materials”), we found that shippers take advantage of the contestable prices for rail transport versus truck. Rail obtains about 60% lower prices than truck for transfer of technical and finished products. The price paid for transport foodstuff and chemical by rail and truck are at the same level.

Rail gets paid better than truck for transfer of foodstuff, and equally well for movement of chemicals. These discrepancies may reflect:

1. Service quality differentials between truck and rail in transfer markets for different cargo categories, and
2. Differences in rail and road positioning in specialty sub-markets for transfer of these goods. Table 2.6 suggests that rail obtains lower prices than truck for transfer by one kilometer of unit ton of technical and finished products

However, considerably lower prices in the market for technical products and finished products are an important competitive advantage of the rail-based services, and may be an important reason why this is the major market for intermodal rail-based services (80% for rail and 48% for truck). For shipments where the transport quality is good enough, the companies can benefit from a lower transport price of rail transport.

Table 2.6: Mean prices for transfer of unit tons of commodity categories by truck and rail (Euro)

Goods Categories (SITC1) Shipped by Rail and Truck	Mean Prices for Unit Ton Carried (Euro)		Mean Prices for Transfer of Unit Ton by One Kilometer (Euro)	
	Truck-	Rail-based	Truck-	Rail-based
Foodstuff	88.27	87.41	0.09	0.13
Chemicals	54.80	54.41	0.05	0.06
Semi-finished products	67.95	35.92	0.06	0.06
Technical products	217.20	87.49	0.28	0.06
Finished products	115.00	50.88	0.10	0.03

It is characteristic, however, that current shipments by rail are big. It is also noticed by analysing the survey data that the shippers that make use of rail services are in general medium to big manufacturers and logistic companies. We explored contents of market demand from small, medium and large European shippers in manufacturing, merchandising and logistics provision industries. So why are the numerous small shippers not making use of rail transport for their numerous small shipments?

The number of rail-based versus truck-only general cargo shipments was 207 (78%) for truck-only and 45 (18%) for rail-based transport. Based on the shippers' reported frequency of each shipment in the representative sample, we find that about 80% of general cargo shipments are by truck (70% for the total sample) and 20% by rail-based solution. But overall for the sample and in particular for the general cargo segment, we find that sizes of truck and rail loadings differ significantly. For truck the mean weight of general cargo shipment is 18 tonnes, whereas for rail it is 346(!), which is the reason why 85% of the volumes of typical shipments in the shippers survey segment were shipped by rail-based solution (Figure 2.5).

This finding has implications for rail and rail-intermodal operators. They should target medium-size manufacturing companies and LSPs for access to stable, large and growing markets for freight services where the rail-based alternative currently constitute a considerable market share. These businesses may have positive experience from usage of freight rail. Therefore, they may harbour greater propensity for extended usage of rail, provided important service quality requirements are fulfilled. Improved rail

services could stimulate these businesses to start using rail-based solutions also for types of shipments that are currently carried by truck.
For small companies rail-based solutions are not as frequent. Shippers that only send small individual shipments usually choose truck-only transport. The reason can be because of entry barriers (e.g., cost of leasing or investing in load carrying units and equipment for drayage) and because they do not have the same bargaining/market power as the bigger shippers and are in reality faced with higher prices for rail-based transport, unless they outsource the transport to a logistic service provider that can consolidate small-sized shipments from several customers into big shipments for rail transport that can be efficiently carried by rail to a lower tonnekm cost than truck transport. Although the market segment for such intermodal transit is small (only 4% of tonnage forwarded by shippers surveyed), it may quickly rise if the quality of rail service is improved. This illustrates the importance of the Logistic Service Providers as a link between the rail-based transport solutions and the markets for freight transport.

Thus, barriers hindering the numerous small shippers from using rail-based transport are:

1. Small shippers have less bargaining power to obtain low prices and other satisfactory qualities of rail-based transport
2. Rail network is less dense than road network
3. Rail services are not feasible unless shippers invest in or lease in new and appropriate LCUs and equipment for drayage
4. Greater truck-only share in value rather than in tonne for the general cargo category indicates that general cargo shipped by truck-only transport has higher value than the type of general cargo shipped by rail-based transport. Thus a reason for the relatively high truck-only shares of shipments shipped by small shippers can be that some elements of transport quality are not acceptable for the general cargo composite shipped by small shippers - regardless of price and the level in other quality dimensions (i.e., below critical levels).

It is crucial, however, to simultaneously understand and satisfy the transport quality requirements of the segments in the market for intermodal services. Identifying and improving the important quality factors is critical in order to understand how to stimulate the market to use rail-based services more frequently and to understand how to increase the competitive interface with other modes of transportation.

3. DETERMINANTS OF SHIPPERS' CHOICE OF TRANSPORT SOLUTIONS

As a basis for analysis of the determinants for shippers' choice of transport solution we developed a basic statistical model structure. The structure consists of antecedent variables, independent variables and dependent variables, where:

- Antecedent: variables used for classifying shippers and commodities shipped in market segments (e.g., by company size, the types of cargo handled, the types of load carrying units (LCUs) used, and the kinds of shipments forwarded).
- Independent: qualitative and quantitative variables used to describe the quality of service experienced by shippers as grouped in terms of the antecedent variables.
- Dependent: variables (two main and one subsidiary) that describe shippers' preference and behavior which depends on the market segment the shipper is part of and the commodity group shipped as well as the transport quality of available transport solutions. The two main dependent variables were:

  (1) The shippers' "desired level of service quality".
  (2) The shippers' actual choices of road and rail lanes.

The overall antecedent variables and the independent variables affect the dependent variable shippers' "desired level of service quality", which is dichotomized in terms of shippers' appraisals of importance and satisfaction of twenty three *transport quality* performance dimensions (Figure 3.1). Importance is defined as the service qualities desired and assigned to the routes chosen before execution of a given shipment. This may differ from the qualities actually delivered. Thus the shippers' evaluation of importance and satisfaction actually identifies two stages in the dispatchers' decision-making: First, the importance served is a standard for finding a suitable offering, while satisfaction provides foundation for inclusion/exclusion of a given transport carrier from a pool of operators eligible for future procurements, i.e., stated preferences for quality required precedes satisfaction with service delivered.

The "desired level of service quality" put constraints on the set of routes that are sufficient transport solutions. The "shipper choice of transport solution" is based on the "desired level of service quality" and the set of available and "sufficient transport solutions".

In this chapter we describe methods used and results obtained by linking data from the shipper's survey to corresponding model variables for analysis of the relationships between the antecedent, the independent and the two main dependent variables.

Crucial for analysis of "shippers' choice of transport solution" was procurement of hard facts on the variation in the independent variables - as stated in terms of service quality on freight routes.

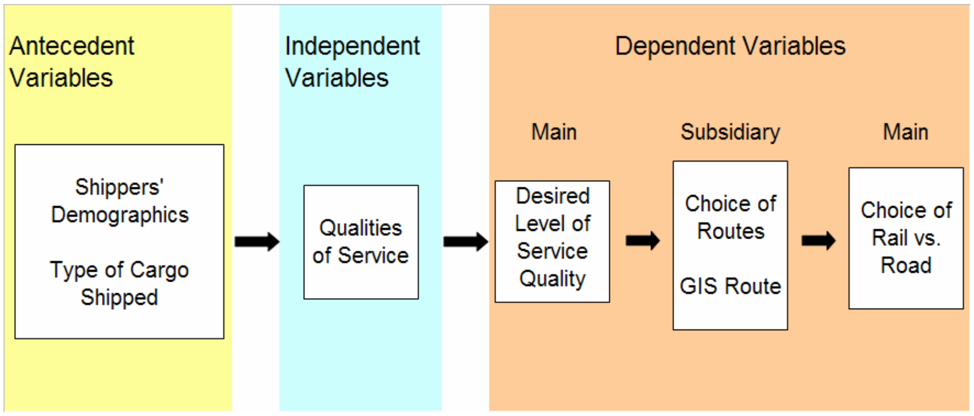

Figure 3.1: Analytical model of relationship among variables affecting the shippers' route and modal choice decisions.

3.1. Rankings of quality dimensions underlying the "Desired level of service quality"

The first main dependent variable "desired level of service quality" was measured from the survey response on the dispatchers' evaluation of importance of and satisfaction with twenty three quality dimensions on the routes chosen. Both importance and satisfaction were measured by five-category Likert scale.

We obtained the shippers' mean assessment scores on how *importance* and *satisfaction* to twenty three quality dimensions varied for the routes served by rail and truck operators (Figure 3.2 and 3.3).

The quality factors rank differently between truck and rail users, Shippers' importance and satisfaction with quality requirements varied more for rail than for truck. By and large, participants in the study were less satisfied with services supplied by rail than by truck. Both negative and positive gaps exist between the service quality expected and delivered by truck and rail.

For truck shipments – the reliability of supply and the cost of service were the most significant quality requirements that deviated from the quality expected, and thus contributed to the negative quality gap. The rail users were most dissatisfied with poor availability of rail service at the shipments' origins and (poor) value for money paid for freight transfer. Reliability of freight delivery, quality of processing of loss and damage, transit time and information promptness on cargo under shipment and after arrival, all scored low on shippers' satisfaction with rail services supplied. Yet, rail operators scored better than road on environmental friendliness, and availability of LCUs suitable for shipment size and types of commodity carried. All in all, rail scored higher on five qualities delivered as compared to shippers' expectations. For truck, the number was seven.

From the survey it was found, however, that the ranking of the importance of quality factors for shipments that were carried out by truck and rail were different. Shippers' importance and satisfaction with quality requirements varied more for rail than for truck. And by and large participants in the study were less satisfied with services supplied by rail than by truck.

This indicates *why* truck conveyance still dominates trans-European transit of goods and what obstacles hinder rail from expansion into the truck-dominated freight market.

This also shows, however, that the level of quality is still above the critical level for the choice of the rail-based alternative despite considerable gap between importance and satisfaction, and although there is less dissatisfaction with truck-only transport we found that shippers benefit from low unit prices for shipment by rail transport.

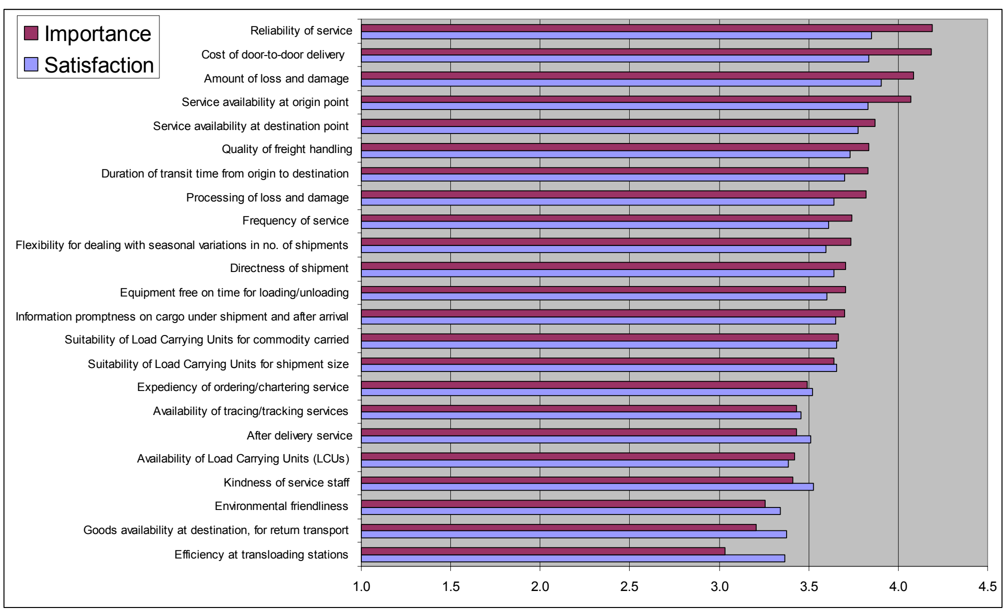

Figure 3.2: Scores of importance and satisfaction assigned by shippers with twenty-three quality attributes of truck service.

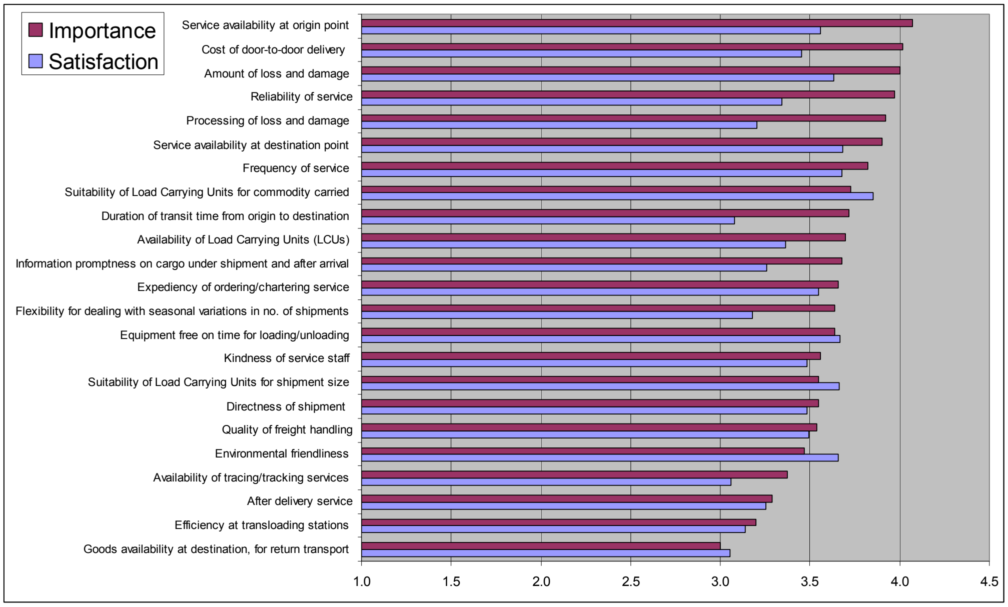

Figure 3.3: Scores of importance and satisfaction assigned by shippers to twenty-three quality dimensions of rail service.

3.2. Factor analysis for analyzing the underlying quality dimensions of "Desired level of service quality"

To identify underlying variables that determine the importance of mode choice, we used factor analysis to determine factors and the size factor loadings of the dependent variable for the importance of the 23 qualitative measures that were evaluated by shippers by Likert scale.

First, factor analysis is applied to extract the main underlying dimensions of the quality construct that explained a large portion of total variance in the dependent variable "desired level of service quality". Then, a principal component method is used to extract several factors from the data (Table 3.1 and 3.3). The group of service attributes that loaded on a given factor composes a particular "dimension of service quality".

Next, to determine the importance of each factor, the shippers' overall rating of quality importance is regressed on ratings of the factors of service quality (Tables 3.2 and 3.4).

3.2.1. Determinants of shippers' choices of road–based freight supply solutions

Five variables loaded on Factor 1, which was interpreted as "*Operational Efficiency and Sustainability*", showing that shippers emphasized the importance of environmental friendliness, kind service, and especially error-free invoicing and prompt information after delivery. Significance of access to information on cargo whereabouts under transfer and efficient trans-loading stations for load consolidation and deconsolidation was also articulated by the users.

Factor 2, interpreted as “*Service Availability”,* involved loadings of three quality indicators that revealed that shippers ranked service availability at shipments’ origins and destinations as important for cost-effectiveness of forward and return trips with import/export shipments. Reliability of service was also in focus here, as service availability may affect consistency of transit time, and delay cargo arrivals and pick-ups.

Factor 3, named “*Dealing with Service Failures*”, comprised loadings of three variables which emphasized the importance that shippers assigned to good after-delivery-service for processing cargo loss and damage, reduction of loss and damage, and the negative consequences of less direct shipments. Similarly to rail carriers, failure by truck and truck-intermodal operators to fulfil these service requirements increases shippers’ financial loss when their cargo gets damaged, lost, and/or delayed. The observation, however, that this factor ranked third in the amount of variance explained in the data material related to truck-served routes reveals that this service dimension is important, but may be better attended to by motorized hauliers than by rail-based operators.

Two variables that loaded on Factor 4, named “*Technical Efficiency”*, indicate that shippers rated as significant suitability of LCUs for the commodity carried and shipment size. This finding confirms a tendency observed in European and the US transportation and logistics markets. According to interviews with leaders from major European and global LSP and manufacturing companies, cheap transport has ceased to be an unstated component of logistics design on which so much of the world’s economy has been based. Lean inventory and globally sourced supply chains depended on cheap transport. However, the consequent huge demand for transport has unsurprisingly resulted in price increases. Greater demand, combined with implications of the political and military crisis in oil-rich Middle East Asian countries, have pushed up the price of fuel. In European countries with tight labor markets, this has brought about higher operations and personnel costs, particularly for truck drivers. Under these circumstances the more one manages to squeeze efficiency out of LCUs’ carrying capacity, the more money is saved on freight shipment.

The latter provides also a causally plausible explanation for Factor 5, named *“Value for Money”,* involving loadings of two variables, the cost of door-to-door delivery and flexibility of dealing with shipments’ seasonal variations. The combination of these two variables underscores the everlasting downward pressures on unit cost of freight movement. It also signifies that price paid for freight conveyance remains an important decision-making factor, even if its ranking was preceded by other quality attributes.

Table 3.1: Service quality dimensions and loadings of importance assigned to qualities of road-based freight supply

Variable	Factor Description	Loadings
Factor 1: Operational Efficiency & Sustainability		
Imp_19	Environmental friendliness	.730
Imp_ 5	Kindness of service	.690
Imp- 8	Efficiency at trans-loading stations	.631
Imp_23	After delivery service	.629
Imp_22	Information promptness on cargo under shipment and	.557
Factor 2: Service Availability		
Imp_ 1	Service availability at origin point	.786
Imp-12	Reliability of service	.753
Imp_ 2	Service availability at destination point	.750
Factor 3: Dealing with Service Failures		
Imp_21	Processing of loss and damage	.855
Imp_20	Amount of loss and damage	.789
Imp_13	Directness of shipment	.678
Factor 4: Technical Efficiency		
Imp_10	Suitability of Load Carrying Units for commodity carried	.845
Imp_11	Suitability of Load Carrying Units for shipment size	.795
Factor 5: Value for Money		
Imp_17	Cost of door-to-door delivery	.816
Imp_18	Flexibility of dealing with variations in no of shipments	.560

Scores of the factors 1-5 from the factor analysis were assessed for each shipment of the sample. Then we performed regression of “desired level of service quality” in terms of importance on the scores of the factors. The factors explained 35 percent of variance in the overall importance assigned by European shippers to service quality on truck routes. Four of the five factors extracted from the data on road transit have significantly contributed to the above. The relatively low percentage of variance explained and the high level of error term indicate that variables other than those in the equation exert causal impacts on shippers’ choices of transport by truck. These variables may be related to cargo specifics shipped and/or to national features of truck service markets in the countries surveyed. Still another explanation could be that important determinants of truck service selection were excluded from our survey instrument, and thus could not be tested by the above model.

Table 3.2: Regression of factor scores on overall importance of road service quality

Independent Variables	Parameter Estimate	Standard Error	t-stat.	p-value
Intercept	3.799	.45	85.184	.000
Factor 2:Service Availability	.241	.045	4.066	.000
Factor 3 :Dealing with Service	.388	.045	6.528	.000
Factor 4: Technical Efficiency	.305	.045	5.134	.000
Factor 5: Value for Money	.281	.045	4.733	.000

3.2.2. Determinants of shippers' choices of rail–based freight supply solutions

Four variables loaded on Factor 1 "*Dealing with Service Failures*", which emphasized the importance that shippers assigned to reduction of loss and damage, needs for staff performing kindly when rendering after-delivery-service, and especially when processing cargo loss and damage. Failure by rail operators to fulfil these service requirements enhances the scope of shippers' financial loss when their cargo gets damaged and/or lost. The fact that this factor explained the largest amount of variance in data material related to rail shipment routes reveals that this service dimension is important, but not necessarily well fulfilled by rail carriers and logistics suppliers who deliver rail-based freight supply solutions.

Three variables loaded on Factor 2, "*Intermodal Expediency*", which shows that shippers emphasized the importance of suitable load carrying devices for commodities carried, reliable transit time for cargo transfer, and efficiently functioning trans-loading stations. Failure to meet these requirements leads to considerable transportation and non-transportation costs for consignors, consignees and LSPs. LSPs who take over cargo after rail haulage waste their time by waiting at trans-loading stations when real time of cargo arrival deviates from the ETA. Inefficient intermodal terminals cause higher inventory and capital costs for retailers and distributors who use more stocks to prevent stock-outs and loss of business. Besides, when cargo arrives later than scheduled by master production plans and/or inventory replenishment timetables, manufacturers suffer from equipment down-time and production stops. LCUs suitable for goods shipped utilize load carrying capacity maximally, and thus reduce the transport costs. LCUs unsuitable for a given cargo category cause under-usage of shipment boxes and/or generate needs for more transport units to expedite the same freight volumes.

Finally, Factor 3,"*Efficiency of Cargo Intake and Discharge"* demonstrates the importance that shippers assigned to expediency of ordering and chartering and equipment free time for loading/unloading. Poor synchronization of freight availability and arrival/departure of transport equipment disturbs delivery schedules and increases the costs of logistics. Late LCU arrivals cause cargo to wait for shipment and, thus, inflate the costs of storage. When cargo discharge is delayed, LSP incur demurrage costs for retaining freight carriage equipment beyond the lease deadlines.

Table 3.3: Service quality dimensions and loadings of importance assigned to qualities of rail-based freight supply

Variable	Factor Description	Loadings
Factor 1: Dealing with Service Failures		
Imp_20	Amount of loss and damage	.654
Imp_23	After delivery service	.804
Imp-21	Kindness of service staff	.709
Imp_10	Processing the loss and damage	.632
Factor 2: Intermodal Expediency		
Imp_10	Suitability of Load Carrying Units for commodity	.814
Imp-16	Duration of transit time	.714
Imp_8	Efficiency at trans-loading stations	.611
Factor 3: Efficiency of Cargo Intake& Discharge		
Imp_4	Expediency of ordering/chartering service	.853
Imp_9	Equipment free time for loading/unloading	.799

Table 3.4 shows the results of regressions run on overall importance of service quality assigned by shippers to rail routes they used for European freight transfer. In order to assess the impacts of shippers' subjective appraisals and contextual factors which jointly affect importance assigned to rail service quality, the model included three *dummies* extracted from descriptive analyses of rail freight flows and rail users. These included FWL and tank-wagon consignments, shipments of foodstuffs and those executed by large and medium-size shippers whose revenues exceeded 10 million Euros.

The 23 model parameters explained 60 percent of variance in the overall importance that European shippers' assigned to rail service quality on routes used. We can see from the t-values that it was solely Factor 2, *Intermodal Expedience*, which contributed to the latter (Table 3.4). Other significant variables included shipments of foodstuffs and shipments by companies with revenues exceeding 10 million Euros. Consignments of full wagon loads and tank wagons, although significant were not considered important for the shippers' assessments of overall service quality. This is understandable given the fact that wagon loads constitute traditional rail service, which usually operates in single-modal fashion. A positive and highly significant impact of Factor 2 signals that shippers attached more importance to efficiency of intermodal operations whose service quality is more important for high-value foodstuffs.

Table 3.4: Regression of factor scores on overall importance of rail service quality

Independent Variables	Parameter Estimate	Standard Error	t-stat.	p-value
Intercept	.158	.485	.326	.746
Full Wagon Loads	-.189	.179	-2.089	.041
Tank-Wagons	-335	.266	-3.731	.000
Shipments of foodstuffs	.184	.279	2.097	.041
Shippers >10-50 million Euros	.241	.192	2.752	.008
Factor 1: Service Failure	.167	.124	1.626	.110
Factor 2: Intermodal Expedience	.632	.105	6.495	.000
Factor 3: Cargo Intake &	.064	.094	.659	.513

3.3. Analysis of determinants of transit time by road and rail

Transit time is one of the highly ranked quality dimensions and the quality dimension with the greatest relative deviation between importance and satisfaction. By regression analysis, we found that route kilometres in transit by the different modes are, not unexpectedly, the strongest determinants for duration of transit time[17].

Therefore, we developed regression models on the dependent variable “transit time” to assess how this factor was affected by (1) transport distance by geographical location of the route, (2) the use of sea transport as part of the route, (3) border crossings, and (4) dummy variables for the type of freight carried and other characteristics of shipments[18].

3.3.1. Transit time by road

The model parameters in Table 3.5 explained 74 percent of variance in time of door-to-door freight transport by road. Route kilometres in transit by the different modes are, not unexpectedly, the strongest determinants (see t-values of Table 3.5 and Figure 3.4) of duration of transit time. However, the negative and significant coefficient values on three dummy variables -- *service with daily frequency*, *shipments of chemicals,* and *consignments with origins located in west-Europe* -- reveal types of shipments that are moved significantly faster, i.e., the transport time on the shipment lane becomes shorter if these dummy variables are active.

[17] Distance is inevitably an important determinant, which we didn’t ask for in the shippers survey because it is easily ascertained by GIS. The regression models on the dependent variable “transit time” assessed how this factor was affected by transport distance and the features of shipment corridors in different countries and regions.

[18] Corresponding analyses can be made for delay (i.e., replace time with percentage delay as dependent variable).

Table 3.5: Significant parameters in linear regression analysis on total transit time by road

Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	9.526	3.440		2.770	.006
Sea transit (km)	.038	.004	.361	8.703	.000
Road km in Western Europe, short route (<1000 km)	.033	.005	.341	6.102	.000
Road km in Western Europe, medium route [1000-2000> km	.029	.003	.520	9.134	.000
Road km in Wester Europe, medium route [2000-3000> km	.032	.003	.597	11.081	.000
Road km in Western Europe, long route (>= 3000 km)	.026	.002	.570	11.064	.000
Road km in Eastern Europe, short route (<1000 km)	.029	.007	.200	4.168	.000
Road km in Eastern Europe, medium route [1000-2000> km	.047	.004	.539	12.552	.000
Road km in Eastern Europe, medium route [2000-3000> km	.037	.004	.392	9.673	.000
Road km in Eastern Europe, long route (>= 3000 km)	.024	.005	.191	4.832	.000
Road km, daily shipments	-.005	.002	-.108	-3.125	.002
Road km, SITC5 (chemicals)	-.009	.002	-.157	-4.208	.000
Road km, origin in west	-.004	.002	-.139	-2.708	.007

a. Dependent Variable: r_time Door-to-door transport time (hours)

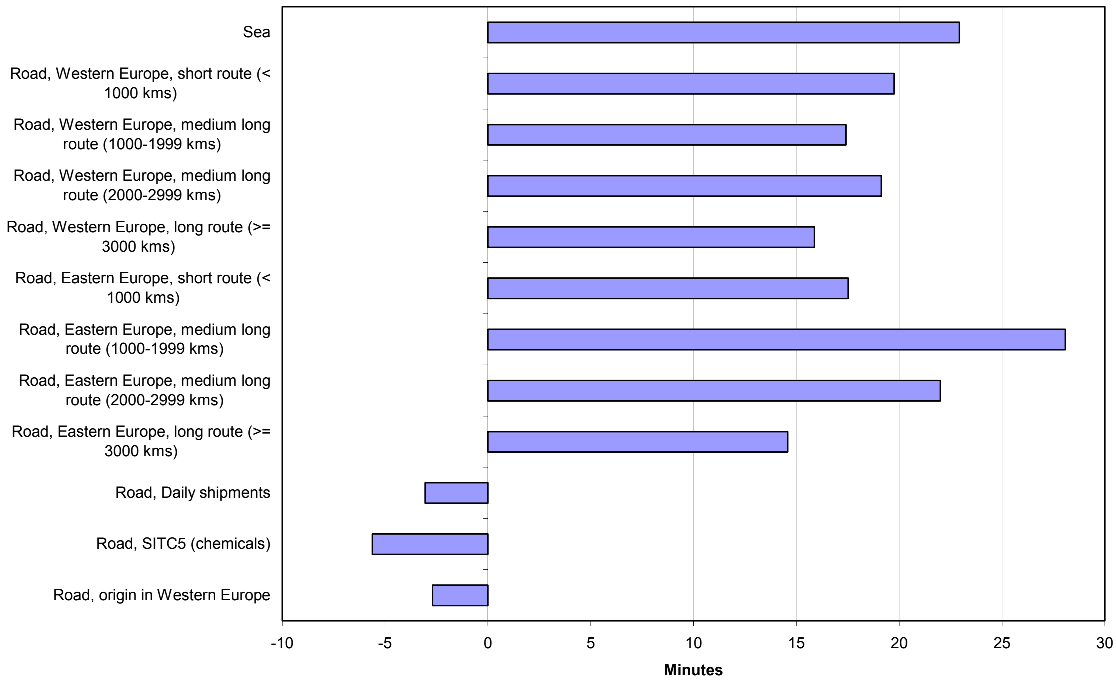

Figure 3.4: Effects of additional 10 km of travel minutes on different segments of truck transit.

3.3.2. *Transit time by rail*

The model explains 64% of variance in duration of freight transport by rail. Rail transit time *increases* with distances of sea crossings, overland haulage, and border crossings into and inside Eastern Europe. The model indicates also that larger shippers manage to reduce transit time for their consignments and that haulage by rail included into intermodal freight transfer shortens shipments' overall travel time. This may happen because large shippers possess efficient service procurement departments who ship large and regular consignments, and their shipments are prioritized by logistic service providers who manage to produce competitive advantage from rail line-haul within intermodal supply. We used the GIS route information as a basis for estimates of freight movement speeds and probabilities of delays on different corridors".

Comparison of determinants of travel times by rail and by road discloses that border crossings on routes have an estimated wait of 14.24 hours (see Table 3.6). This is due to border crossings on east-European corridors that do influence duration of freight travel by rail. Yet, this did not apply to west European lanes. Through west and east-Europe border crossings do not affect duration of truck transport. These findings provide empirical support for anecdotal evidence that long stops at borders in north-eastern and south-eastern European countries disrupt freight movement by rail and, by so doing, constitute significant barriers to seamless freight flows.

Table 3.6: Significant parameters of linear regression analysis on transit time by rail

Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	9.457	10.387		.911	.367
Sea transit (km)	.092	.017	.519	5.534	.000
Rail km in Eastern Europe, short route (<1000 km)	.054	.025	.286	2.201	.032
Rail km in Eastern Europe, medium/long route (>= 1000 km)	.047	.014	.497	3.254	.002
Rail km in Western Europe, intermodal short/medium route (<2000 km)	.068	.014	.459	4.705	.000
Rail km in Western Europe, unimodal short/medium route (<2000 km)	.072	.013	.655	5.494	.000
Rail km in Western Europe, intermodal medium/long route (>=2000 km)	.060	.009	.726	6.675	.000
Rail km in Western Europe, unimodal medium/long route (>=2000 km)	.091	.015	.663	6.289	.000
No of rail border crossings into or in Eastern Europe	14.240	5.797	.359	2.456	.017
Rail km, medium/large company (>10 mill EUR)	-.044	.007	-.722	-5.943	.000
Rail km, crude materials	.038	.010	.328	3.928	.000

a. Dependent Variable: r_time Door-to-door transport time (hours)

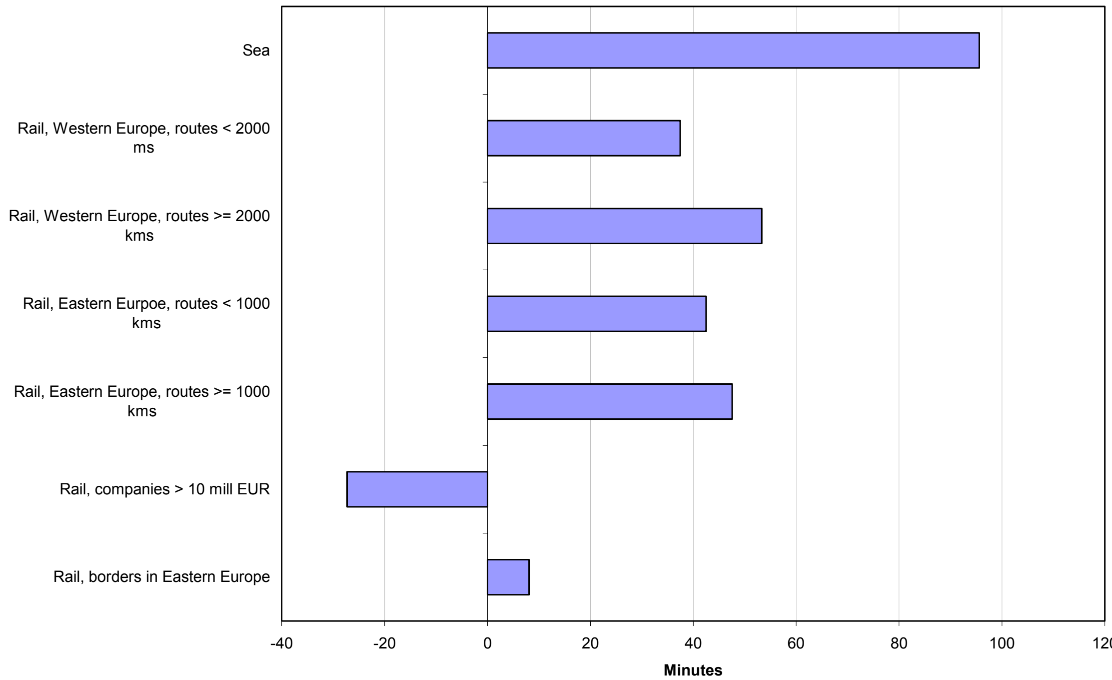

Figure 3.5: Effects of additional 10 km of travel minutes on different segments of rail transit.

4. MARKET CONDITIONS FOR NEW AND IMPROVED RAIL SERVICES IN THE REORIENT CORRIDOR

At an early stage in the research, the geographical scope of REORIENT was narrowed to a freight corridor that connects the Nordic countries with Central- and South-Eastern European states that became new members of the European Union. The REORIENT Corridor covers 11 countries[19].

Seaborne transport between ports in the Nordic countries and in Poland is needed for connection of the northern and southern part of the corridor. North of the Baltic Sea is a well developed network of rail shuttle services to economic centres in the Nordic region. To the south, there are currently primarily conventional rail services (see Appendix A for a brief description of the intermodal ports and hubs in the REORIENT Corridor).

The socio-economic situation varies considerably from country to country within the corridor. Countries in the northern part (Norway, Sweden and Finland) are social democracies with a relatively high standard of living. Sweden, Finland and Austria have been EU members and have benefited from the open market for 11 years and Greece

[19] Norway, Sweden, Finland, Poland, Austria, Czech Republic, Slovak Republic, Hungary, Romania, Bulgaria and Greece.

for 25 years. Bulgaria, the Czech Republic, Hungary, Poland, Romania, and Slovakia became accession countries in December 2002 and became members in May 2004. Also of relevance for the REORIENT Corridor are the Baltic States Estonia, Latvia, and Lithuania, and the former Yugoslavian republic Slovenia, which became members in 2004, whereas Norway is still not a member.

The population in millions of people by REORIENT country (year 2002) gives an indication of the market for consumables, which is an important part of the market for international intermodal transport services: Norway (4.5), Sweden (8.9), Finland (5.2), Poland (38.2), Austria (8.1), Czech Republic (10.2), Slovakia (5.4), Hungary (10.2), Romania (21.7), Bulgaria (7.9) and Greece (10.7).

Statistics from the World Trade Organisation (WTO) and data for year 2000 from ETIS-Base were used to assess the magnitude of REORIENT countries' freight exchanges by their total trade - the share of trade between REORIENT countries and the countries located in the nearby western hinterland (Table 4.1). The share of the REORIENT country trade with the EU twenty five member states vary between 86% and 53%. Trade with Germany and Italy is important. Germany's large, versatile and export-oriented economy has traditionally supplied technology, industrial equipment and consumer products. The trade among the REORIENT countries varies between 12.9% and 4.3%, indicating significant economic importance. Intra-corridor trade is greatest for countries located in central parts of the corridor.

Table 4.1: REORIENT countries/regions total import and export (US$ and € billion) and the shares traded with other REORIENT countries and EU25 countries (year 2004-2005) [20]

	Total Export ($)	Total Import ($)	Export within REORIENT (€)	Import within REORIENT (€)	EU25 export	EU25 import
Nor/Swe	104/130	56/111	**13.2 (4.3%)**	**11.0 (5.0%)**	79/58%	71/71%
Finland	66	59	**9.7 (11.3%)**	**8.8 (11.4%)**	56%	58%
Bulgaria/Romania/Hungary	11/28/62	18/41/66	**9.4 (7.1%)**	**12.9 (7.9%)**	55/68/75%	50/62/67%
Austria/Czech/Slovakia	124/78/32	126/77/35	**14 (4.6%)**	**12.9 (4.1%)**	70/86/85%	75/72/63%
Poland	89	101	**6.2 (5.3%)**	**9.4 (7.1%)**	79%	68%
Greece	17	53	**1.8 (8.4%)**	**3.2 (4.7%)**	53%	56%
Total	741	643	**6.3%**	**7.7%**		

Underlying the figures is the situation that Norway has large oil and gas production. Oil and gas is exported directly by pipe and boat, but Norway does not export oil and gas to

[20] Total merchandise import (cif) and export (fob) and EU twenty five trade were obtained from WTO (http://stat.wto.org) and were used together with freight flow data for year 2000 from ETIS-Base to assess the share of total trade that takes place within the REORIENT Corridor. Approximate 2005 levels of export and import within the corridor were based on data for year 2000 from ETIS-Base and projected growths in the baseline SCENES scenario 1995-2025.

Central and South-Eastern Europe. Nordic trade with other REORIENT countries includes fish, building materials, and manufactures like furniture and paper and food products.

The Polish trade with Germany amounts to 25% of Polish export activity and 28% of Polish import activity. Also the Russia/Ukraine region is important for Poland. By value, 7% of Polish export trade is directed to Russia/Ukraine and 12% of Polish import trade comes from these countries.

Vienna in Austria is an important hub for rail transport in the REORIENT Corridor and in Europe. The transport flow between Austria and Germany was the 7th largest country-to-country intra EU flow in 2004, where 4.5% of all intra-EU tonnes were carried (Statistics in focus 10/2005). Growth in Austrian export/import and transit traffic is higher than the growth in domestic transport flows. High growth commodities are typical truck-only commodities and correspondingly the percentage of truck-only growth was greater than the rail based transport of these commodities. For Austria, the United States is also important for both export (5.7%) and import (3.4%) and Austrian trade was to a great extent in the westward direction.

Trade with the EU25 is very important for Bulgaria, Romania and Hungary. Italy and Germany are the most important countries in this trade. Turkey is also an important trade partner. Romanian producers appear to be core rather than marginal suppliers and are therefore not excessively vulnerable to fluctuations in import demand in highly developed markets. Garment is Romania's most important export article, but equipment has also become important. The most important export from Bulgaria is footwear and clothing and also iron and steel and other metals. Greatest import goods are crude oil and natural gas.

The income per capita varies, however, and could have an impact on the extent to which there is a market for import of certain commodities to some countries, e.g., the EC's 2002 regular report on Bulgaria noted that average per capita income was at 28% of the EU average. Changes took place in Bulgaria during the transition period, however, which included the liberalization of trade and a more clearly defined and predictable trading regime. The rapid economic growth indicates that the changes have effects and that the average income will increase relative to the other countries (GDB increase in year 2000 was 5.8%).

For Greece the main export partners are Germany (12.6%) and Italy (10.5%) (2003). Greece's imports increased from €17 billion to €39 billion and exports increased from €8 to €12 billion during the period 1995-2003. Thus, the big trade deficit shown in Table 2.1. Key sectors of the Greek economy are manufacturing, commerce, services and tourism (with increasing profitability in manufacturing, commerce and service but downturn in tourism). Corridor and maritime connections constitute a dense network of both ro-ro and containerized maritime transport, and there is significant trade with trade partners in the Mediterranean region.

Specifically, from ETIS-Base, the percentage of Norwegian, Swedish, and Finnish export to South-Eastern/Central Europe[21] (in tonnes) are 0.4/0.4, 2.0/2.7, and 1.9/1.4, respectively. The percentage import from South-Eastern/Central Europe to Norway, Sweden, and Finland are 1.2/2.3, 0.3/2.3 and 0.3/4.17.

The South-Eastern Europe export share to Central Europe is 2.75% and from Central Europe to South-Eastern Europe it is 5.2%. The South-Eastern Europe import share from Central Europe is 5.2% and vice versa 1.7%.

4.1. Directional imbalances of total freight flows between regions in the REORIENT Corridor

The directional imbalances of overall freight flows may affect capacity utilization and therefore the economy of round trips for the rail-based services. Both the magnitude and the structure of trade are important for the REORIENT Corridor's capacity utilisation and the profitability of new rail freight services.

ETIS-Base data show that the southbound and the northbound tonne volumes flowing between the Nordic region and the other REORIENT Corridor countries are balanced (6.3 million tonnes in each direction). In value, however, the northbound flow is 36 percent smaller. Tonnage balance but imbalance in value is explained by the different composition of, and the different density of, the flows traded.

Specifically, between the Nordic countries and South-Eastern Europe, a total flow of 3.7 million tonnes is shipped southbound and 1.1 northbound -- a deficit of 60% in northbound flows in tonnes and the same deficiency in value.

4.1.1. Export/import imbalances between six corridor regions

For each of the six corridor regions $i, j \in$(Norway/Sweden, Finland, Bulgaria/Romania/Hungary, Austria/Czech/Slovak, Poland and Greece), we assessed the overall weighted trade imbalance, Tot Im, by $100 * \sum_i |\text{Export}_i - \text{Import}_i| / \sum_j \text{Export}_j$, where Export_i and Import_i is the amount of export and import trade of country i with other corridor regions. i.e., Tot Im is the sum of absolute value of trade imbalances per region divided by total trade between regions. In tonnes, the overall weighted trade imbalance over the regions is 33% of total trade (based on Table 4.3). Corresponding imbalance in value is 16% (based on and Table 4.2). The main reason why the imbalance tends to level out in value is that the value of goods exported to Norway and Sweden is higher than the value of goods imported from Norway and Sweden (Table 4.4). Also, Bulgaria/Romania/Hungary has a relatively big surplus in tonnes in trade with

[21] Countries within the regions are: SE-Europe (Balkan, Bulgaria, Greece, Romania, Turkey/Cyprus), W-Europe (Austria, Italy/Malta, Czech, Germany, Denmark, Benelux, France, Morocco, Spain, Switzerland, UK/Ireland, Iceland), C-Europe (Poland,Hungary,Slovakia), E-Europe (Russia, Belarus, Baltic states, Moldovia and Ukrainia). The numbers for trade within and between Asia/Africa and America are European trade, only.

Greece that levels out in value. Trade between Bulgaria/Romania/Hungary and Austria/Czech/Slovakia is balanced in both value and tonne. Bulgaria/Romania/Hungary has a deficit in trade with Poland that also levels out in value.

In more detail, we find for Finland that the import is 2.8 million tonnes and the export only 1.3 million tonnes in trade with other REORIENT countries (except Norway/Sweden), where the coal from Poland to Finland contributes to the deficit[22]. This balances out overall for the Nordic countries, since the opposite is found for Norway/Sweden. From Table 4.2 we find for instance that in value Poland is a net importer. However, Bulgaria/Romania/Hungary is break even and Australia/Czech/Slovak is a net exporter.

Table 4.2. The value (€ million) of freight flows between countries/regions in the REORIENT Corridor based on data for year 2000 from ETIS-Base

	Nor/Swe	Finland	Bulg/Roman/Hung	Aust/Czech/Slovak	Poland	Greece	**Total export**
Nor/Swe	0	6273	662	1821	1928	708	**11392**
Finland	5659	0	435	1052	768	379	**8292**
Bulg/Roman/Hung	614	124	0	5516	709	1081	**8044**
Aust/Czech/Slovak	1625	616	5255	0	4461	454	**12410**
Poland	1368	267	707	2843	0	149	**5333**
Greece	146	233	986	167	97	0	**1629**
Total import	**9411**	**7512**	**8044**	**11399**	**7963**	**2770**	

Table 4.3. The total international freight flows within and between regions in the REORIENT Corridor as derived from data for year 2000 from ETIS-Base (1000 tonnes)[1]

	Nor/Swe	Finland	Bulg/ Roman/ Hung	Aust/ Czech/ Slovak	Poland	Greece	**Total regional export**
Nor/Swe	19725	10268	545	1783	2341	423	**15360**
Finland	4901	0	145	463	419	267	**6195**
Bulg/Roman/Hung	183	69	1097	5626	815	1671	**8364**
Aust/Czech/Slovak	708	238	5206	24317	8153	438	**14743**
Poland	2578	2397	1532	8385	0	58	**14950**
Greece	103	67	988	168	166	0	**1492**
Total regional import	**8473**	**13039**	**8416**	**16425**	**11894**	**2857**	

[1] Domestic transport is excluded.

[22] This is a one-way flow that has declined in recent years. The biggest Finish export flows in REORIENT context are to Austria and the Czech Republic, to which Finland exports paper and steel-based products. Finnish import is mainly metal and steel.

Table 4.4. € per tonne of freight flows between regions in the REORIENT Corridor as derived from data for year 2000 from ETIS-Base

	Nor/Swe	Finland	Bulg/ Roman/ Hung	Aust/ Czech/ Slovak	Poland	Greece	**Regional export (average)**
Nor/Swe	-	611	1215	1021	824	1674	**742**
Finland	1155	-	2999	2271	1833	1418	**1328**
Bulg/Roman/Hung	3356	1801	-	981	870	647	**962**
Aust/Czech/Slovak	2295	2586	1009	-	547	1036	**842**
Poland	531	111	461	339	-	2565	**357**
Greece	1417	3483	998	995	583	-	**1092**
Regional import (average)	**1111**	**576**	**956**	**694**	**669**	**970**	

4.2. Composition of freight flows between the REORIENT Corridor countries

ETIS-Base contains unique information of the freight flows by transport chains with information of the mode from origin, between a maximum of two transhipments and from the last transhipment to the destination. Modes can be road, rail, inland waterway, sea, other, and unknown. For REORIENT we classified possible transport chains as (1) truck-only, (2) rail-based, and (3) other modes of conveyance, where the first is only road, while rail-based is any transport chain where rail is used on at least one leg and the latter comprise combinations of boat, inland waterway, airborne transport, pipeline etc., but no rail.

According to ETIS-Base, the overall mode shares of (1) truck-only, (2) rail-based, and (3) other *international* freight flows of transport between the six corridor regions[23] are 16%, 46%, and 38% (in tonnes)[24], respectively (18%, 47%, and 35% if we take transport between countries within regions into account). Overall mode shares in value between the six regions are: 34%, 23%, and 43%, respectively. In fact the rail share is lower in terms of value than in terms of tonnes for all commodity groups (Table 4.5). Overall, this indicates that commodities transported by rail-based solution have lower value than those transported by truck-only. From ETIS-Base we find that Central European countries are the leading countries with regard to rail shares for import and export flows.

The average values of freight flows between six corridor regions are: for general cargo 2388 (€/tonne). For liquid bulk the average value is 270 (€/tonne), but the value varies considerably. For semi-bulk the average value is 560 (€/tonne). For dry-bulk the

[23] Nor/Swe, Finland, Bulgaria/Romania/Hungary, Austria/Czech Republic/Slovakia, Poland and Greece.

[24] Exploration of mode specific OD matrices is needed in order to determine tonnekm by the different modes between the OD pairs. This is postponed as it is easier to do as part of the network modelling.

average value is a fairly low 72 (€/tonne). For vehicles, the variation is small. The average value is 6803 (€/tonne). Crude oil is transported only between a few relations and the variance in the price is fairly small around the average of 238 (€/tonne).

We find overall that the share of rail-based transport is low for commodity groups with a relatively high value (Table 4.5). Still, rail-based solutions are well represented for all commodity groups. We also find that, overall, the rail share varies considerably with trade relations within the corridor (Table 4.6).

Table 4.5: Overall mode shares (%) of international freight transport between the corridor regions[1] by commodity group in terms of tonne/value

	General cargo	Liquid bulk	Semi bulk	Dry bulk	Vehicles	Crude oil
Truck-only	33/40	6/7	26/21	6/11	44/41	0/0
Rail-based	30/18	36/35	43/37	66/59	26/20	3/2
Other	27/42	58/58	31/42	28/30	30/39	97/98

[1] Norway/Sweden, Finland, Bulgaria/Romania/Hungary, Austria/Czech Republic/Slovakia, Poland and Greece.

Table 4.6: Percentage rail-based of total international freight flows within the corridor (based on tonnes)

	Nor/Swe	Finland	Bulg/Roman/Hung	Aust/Czech/Slovak	Poland	Greece
Nor/Swe	6.54	0.83	24.04	13.97	6.45	2.84
Finland	0.98	0	3.45	17.49	8.11	0
Bulg/Roman/Hung	3.28	2.9	74.75	51.32	54.48	17.3
Aust/Czech/Slovak	28.25	19.33	74.24	80.83	85.85	42.92
Poland	59.15	87.4	80.35	86.94	0	17.24
Greece	0.97	0	5.36	13.1	0	0

In a broader geographical sense, we also found from official statistics that the share of international freight volumes carried by rail-based solutions varies considerably geographically (Table 4.7 and 4.8). We have relatively high market share between Central- and South-Eastern Europe (57%), between Central Europe and Western Europe (43%), and between South Eastern Europe and Western Europe (12%). A great share of the flows is carried by transport solutions other than the land based transport of truck-only and rail-based, however (e.g. seaborne, inland waterway and airborne). Freight shares between the Nordic region and other regions in the REORIENT Corridor are generally lower than between the Nordic region and Western Europe. An exception is northbound from Central Europe to the Nordic region, which contains big amounts of coal from Poland to Finland.

Table 4.7: Percentage rail-based share of total freight flows between REORIENT Corridor- and hinterland regions in year 2000 (based on tonne). Source: ETIS-Base

	Nordic region	South-Eastern Europe	Western-Europe	Central-Europe
Nordic region (*)	-	4.54	7.15	6.24
South-Eastern Europe	1.04	0.	13.	55.67
Western Europe	5.74	10.79	0.	42.98
Central Europe	69.2	57.54	54.81	0.

(*) A great share of the import/export flows from this region is not conveyed by land based transport.

Table 4.8: Percentage rail-based versus truck-only transport of total freight flows in year 2000 (based on tonnes). Source: ETIS-Base

	Nordic region	South-Eastern Europe	Western-Europe	Central-Europe
Nordic region	-	52	73	36
South-Eastern Europe	16	-	36	62
Western Europe	43	25	-	49
Central Europe	98	60	65	-

4.2.1. General cargo

The volume of general cargo from the Nordic Countries to other REORIENT countries exceeds the southbound by 86% (2.2 million tonnes southbound and 1.2 northbound). The northbound commodities are more diversified than the southbound. But still, the southbound flows exceed the northbound by 61% in value. This complies well with earlier research in the PolCorridor LOGCHAIN Project (2006) where it was identified based on foreign trade statistics that the south-bound volume of commodities defined as relevant for land transport exceeds the north-bound volume by 60%. Also according to LOGCHAIN Project (2006), in 2002 Sweden shipped 58 percent of all volumes of cargo relevant for rail-based shuttle services, 29 percent of freight came from Finnish trade, and only 13 percent had Norwegian origins and destinations. Taking ETIS data and only REORIENT countries into consideration, a somewhat greater share is due to Finnish trade (55% in tonnes and 60% in value).

The average value of international general cargo freight flows in the REORIENT Corridor by truck-only is €3398 per tonne and by rail-based transport it is €2107 per tonne[25]. The truck-only versus rail-based share by tonne is 33-30 and by value it is 40-18. For dry bulk the value of freight shipped by truck-only is €197 per tonne and by rail-based it is €89 per tonne. The truck-only versus rail-based share by tonne is 6-66 and by value it is 11-59. Thus also, bulk by truck-only has a higher value than bulk by rail-based solution. A similar trend is found also for other commodity groups.

In more detail, we derived the total value for general cargo shipments between the Nordic countries and a set of other REORIENT regions and truck versus rail shares between the regions. The flow shares northbound to the Nordic countries are 29% from Poland, 18% from Bulgaria/Romania/Hungary, 45% from Austria/Czech/Slovak, and 8% from Greece. The values of the flow are[26]: €1940, €3880, €4410, and €3870 per tonne, respectively. Because of the low value per tonne of Polish general cargo, the Polish share in tonnes becomes 47%. The truck versus rail shares for the flows are (%): 3-16, 16-6, 23-21, and 6-2.

Southbound, the shares are 35% for Poland, 16% for Bulgaria/Romania/Hungary, 34% for Austria/Czech/Slovak, and 15% for Greece. The values of the flows are €1990, €4210, €3790, and €2430 per tonne, respectively. The truck versus rail shares are (%): 16-6, 23-10, 18-15, 6-3.

It is also noticed that modes of transport not covered by truck-only and rail-based are dominant in both northbound and southbound direction across the Baltic sea (i.e., combinations of *road*, *rail*, *inland waterway*, *sea*, *other,* and *unknown*), but less dominant for international transport with origin and destination south of the Baltic sea.

Geographical differences and truck-only versus rail-based differences in the value of general cargo flows indicate that general cargo is a composite commodity group, and that truck-only and rail-based transport serve different segments of the general cargo commodity type. Greater shares of rail service for the low value general cargo from Poland confirm the overall picture by taking all commodities into account, that high value products have a greater truck-only share. But relatively high rail shares for general cargo composites of higher value conveyed on other trade relations where we know there are better rail-based services indicate that availability and improved quality of rail-based services may increase the rail-based share of high value products.

[25] For the total flows the average value of freight flows within the REORIENT Corridor is €770 per tonne.

[26] From ETIS-Base we found that the average value of international shipments general cargo within the corridor is €2332 per tonne.

We find from Tables 4.9 – 4.11 that general cargo from Poland is of fairly low value per tonne, but a big share of the total northbound flow and the share of rail-based solution is high. The value of Polish freight in the opposite direction is also somewhat below average. General cargo freight from Greece to the Nordic countries is of high value but relatively small in magnitude and the value of freight in the opposite direction is on the average**.** However, general cargo shipped between the Nordic countries and the regions B/R/H and A/C/S has a high value per tonne and considerable volumes in both directions, and the rail share is fairly high.

Table 4.9: Volume of general cargo (tonne)

	Nor/Swe	Finland	Bulg/Roman/Hung	Aust/Czech/Slovak	Poland	Greece
Nor/Swe	3271	1829	111	303	774	222
Finland	1290	0	111	241	266	154
Bulg/Roman/Hung	133	35	380	1729	430	344
Aust/Czech/Slovak	276	96	1271	3500	1949	206
Poland	441	114	298	1116	0	20
Greece	39	38	284	82	120	0

Table 4.10. Value of general cargo (1000 € per tonne)

	Nor/Swe	Finland	Bulg/Roman/Hung	Aust/Czech/Slovak	Poland	Greece
Nor/Swe	0	2.34	4.78	3.9	1.85	2.63
Finland	2.93	0	3.65	3.64	2.39	2.14
Bulg/Roman/Hung	4.23	2.52	0	2.69	1.31	2.05
Aust/Czech/Slovak	4.01	5.58	3.24	0	1.5	1.42
Poland	2.18	0.99	1.42	1.53	0	4.73
Greece	3.01	4.76	2.73	1.67	0.69	0

Table: 4.11. Shares (in terms of value) of general cargo transported by rail-based solution

	Nor/Swe	Finland	Bulg/Roman/Hung	Aust/Czech/Slovak	Poland	Greece
Nor/Swe	0	1.84	16.02	17.54	3.84	4.54
Finland	2.1	0	2.71	10.7	9.58	0.12
Bulg/Roman/Hung	6.29	6.21	0	23.94	42.04	10.47
Aust/Czech/Slovak	17	29.33	25.95	0	50.13	32.58
Poland	14.94	26.32	35.22	46.15	0	26.64
Greece	6.03	0	1.6	0.09	0.36	0

4.3. Corridors for freight transfer between REORIENT countries

From the shippers survey carried out in REORIENT and survey work in earlier research projects (Scandient, PolCorridor LogChain Project) we found that goods shipped between the REORIENT countries often transit over Germany despite the scarcity of infrastructure capacity or through other route choices. A reason is that services through Germany are still preferred, which is to some extent explained by low investments in the REORIENT Corridor, resulting in insufficient transport quality for certain goods types.

A total flow of 3.7 million tonnes is shipped southbound and 1.1 northbound between the Nordic countries and South-Eastern Europe. From ETIS-BASE we found that 19 thousand tonnes of this flow (i.e., about 0.5% of the total flow) is transhipped from one ship or conveyance to another either in Germany or Poland, This excludes transit via ro-ro ships which is considered part of the road in ETIS-Base[27]. Of the 19,000 tonnes, only a tiny part is transhipped via Poland. Of the total northbound flow of 1.1 million tonnes, 18 thousand tonnes is transhipped in Germany or Poland (i.e., about 1.7% of the total flow). Of the northbound flow about 1/3 is transhipped in Poland and 2/3.in Germany. Overall about 17% is transhipped in Poland. Of the total flow, 17% amounts to 663 thousand tonnes in year 2000, but some of the total transport may use other routes than through Poland and Germany. Thus the amount was less in year 2000 but has grown because of steady economic growth and industrial changes. This also gives an indication that there is a great potential for attracting freight from competing transport routes to possible new international rail-based transport services through the REORIENT Corridor.

With added information from Eurostat (2004), we deduced that about 14% of the turnover in Polish ports that originates or is destined for the Nordic countries is in transit to South-Eastern Europe.

4.3.1. Freight transhipped in Poland

In detail, the only freight from the Nordic countries transhipped in Poland to SEE countries is a total of 78 tonnes that are moved from Sweden to Slovakia. The freight is transhipped in Zachodniopomorskie (PL0G), which is the province where Swinouitzie is located. All 78 tonnes from the Nordic countries to the SEE countries transhipped in Poland are vehicles moved by rail-based transport solution (manifestation group 34).

There is more in the other direction. From Hungary to Finland a total of 1028 tonnes was transhipped in Poland and from Slovakia a total of 1461 and 1356 tonnes were moved via transhipment in Poland to Sweden and Finland. In total, the northbound freight flows transhipped in Poland amounts to 3845 tonnes. All transhipments for these flows are located in Zachodniopomorskie (PL0G) and Pomorskie (PL0B) where Gdansk is located. They are all carried by rail-based solutions. It is 3423 tonnes general cargo, 353 tonnes semi-bulk, and 70 tonnes of vehicles.

[27] We made one query to ETIS-Base for all flows in both directions between zones in the Nordic countries and zones in a set defined as South-Eastern European countries: Albania (AL), Makedonia (MK), Bosnia (BA), Herzegovina (HR), Serbia (SI), Yuogoslavia (YU) (Balkan), Bulgaria (BG), Cyprus (CY), Slovakia (SK), Romania (RO), Hungary (HU), Greece (GR).

4.3.2. Freight transhipped in Germany

Of the freight transhipped in Germany, we have that freight from Norway, Sweden, and Finland to Greece amounts to 2.2, 10.3, and 1.7 thousand tonnes, respectively. Between the Nordic countries and Turkey&Cyprus, the transhipped freight amounts to 0.5, 3.3, and 0.1 thousand tonnes. Freight transhipped from Norway on its way to Hungary and Slovakia amounts to 0.4 and 0.1 thousand tonnes. Overall, the freight flow between the Nordic countries and South-Eastern Europe that is transhipped in Germany amounts to 18.7 thousand tonnes (based on ETIS data for year 2000).

In the other direction, the freight flows transhipped in Germany on its way from Greece to Sweden and Finland amounts to 3.0 and 7.0 thousand tonnes, respectively. From Turkey&Cyprus, the amount to Norway, Sweden, and Finland is 0.6, 0.9, and 0.1 thousand tonnes. Goods from Balkan to Norway and Sweden amount to 0.2 and 0.1 thousand tonnes. From Hungary to Norway and Finland, the amount is 1.6 and 0.1, and from Romania to Sweden it is 0.1, a total of 13.6 tonnes.

There is transhipment of all commodity groups, but general cargo is the dominant commodity being transshipped (Table 4.12)

Table 4.12: The amount of freight (in tonnes) moved between the Nordic countries and South-Eastern European countries (SEE countries) that is transhipped in Germany by truck-only/rail-based/other

	General cargo	*Liquid bulk*	*Semi-bulk*	*Dry bulk*	*Vehicle*	***Total***
Nordic to SEE	12841 (0/61/39)	131 (0/42/57)	3744 (0/39/61)	1826 (0/0/100)	127 (0/49/52)	**18669** (0/50/50)
SEE to Nordic	10627 (0/18/82)	870 (0/0.6/99.4)	1367 (0/9/91)	747 (0/0/100)	0 (0/0/0)	**13611** (0/15/85)

4.4. Uncertainties and growth

In the market for European freight transport, the situation is changing quickly because of economic and industrial changes and growth. Freight flows have changed towards year 2007 and will continue to change considerably in years to come because of economic growth and structural changes in the economies. For the REORIENT countries we have in general that growth in consumption is lower than the growth in external trade (based on EIO, 2002), which means that export/import replaces some production for domestic consumption. In the PolCorridor LOGCHAIN Project (2006) report it is emphasised that growth in export, import and private consumption are believed to have the largest causal impact on growth in international goods trade. Important factors that govern these economic dimensions are:

1. Industrial development, increasing import/export activity and less production for domestic consumption (structural changes towards distributed).
2. Inclusion of new member states as of May 21, 2001 and removal of custom at borders
3. The introduction of € in year 2001

4. Increasing demand because of population growth and increasing private income for consumption.
5. Increased interest rates in the beginning of 2005 throughout the EU area (which affects prices on capital and financial services)
6. Fuel prices increased in the period from 2000 – 2005
7. Liberalisation of the railway business led to a 15%-25% cost reduction of rail services (pers.com Johanna Ludvigsen) plus many other known and unknown determinants.

An option to take into account the recent changes in the market would be to assess flows for year 2006 by linear interpolation between projection for year 2020 from ETIS-Base and the empirically based flows for year 2000 from ETIS-Base. Representatives from NEA (the lead institution for establishing ETIS-Base) warned, however, that interpolation could possibly introduce big errors, as the underlying growth is non-linear.

Instead we used SCENES model predictions specifically for year 2006 (based on the baseline SCENES scenario -- 1995-2025) that were obtained by the PolCorridor LOGCHAIN Project (2006). From the SCENES growth rates we obtained the expected growth in tonnage transported between regions over the five-year period 2001-2006 (Table 4.13).

Table 4.13: Percentage growth in tonnes transported between origin and destination regions, 2001-2006, for all goods types and all transport modes

To From	North	North-East	South	Central
North	-	-	17 %	20 %
North-East	-	-	16 %	19 %
South	18 %	20 %	-	18 %
Central	19 %	21 %	15 %	-

North: Finland, Norway, Sweden, *North-East*: Belarus, Estonia, Latvia, Lithuania, Russia, *South*: Albania, Bosnia-Herzegovina, Bulgaria, Greece, Italy, Yugoslavia, Croatia, Macedonia, Moldova, Romania, Slovak Republic, Slovenia, Turkey, Ukraine, Hungary. *Central*: Poland, Czech Republic, Austria.

From foreign trade statistics we have that relevant commodity categories for market potential[28] correspond with most rapidly growing goods types traded between the Northern and Southern corridor regions over 1999-2002. While the total transport demand (in tonnes) increased over 1999-2002 by 18 percent, the corresponding growth in relevant cargo was 21 percent in Southbound flows and 24 percent in Northbound flows over 1999-2002, which helped to compress the direction imbalance. If this

[28] Group 1: Cereals, agricultural products, and consumer foodstuffs, Group 2: Metal products, cement and manufactured building materials, crude building materials, and miscellaneous manufactured goods, Group 3: Basic chemicals, fertilizers and plastics, Group 4: Large machinery and small machinery, Group 5: Solid fuels and ores.

development continues, it will, over time, improve the capacity utilization and the profitability of transport operators.

Based on calculations with the SCENES model, we find that transport (tonnes) of the relevant commodity groups between the Northern and Southern regions are estimated to grow by 21 % from 2002 to 2007.

In particular, exports of machinery from the Northern region are expected to increase considerably. In the Southern region, foreign corporations, especially those in the automobile industry, are waiting in line to invest in Slovakia. Hundai, Volkswagen, Kia, Peugeot/Citroen are all profiting from low wages and taxes and rejoicing over investment assistance. People are already talking of a "Detroit of Europe." For the car manufacturing industry in Slovakia, production of VW cars from 1994 to 2004 were 222000 cars and 350000 gear units (1994-2004). PSA Peugeot Citroën has started to build up its car manufacturing at the city of Trnava and estimates 500000 cars per year by 2010! By the end of 2006 KIA began producing 300 000 cars per year at Zilina. The industry needs international container transport of parts upstream in the value chain.

5. NEW RAIL SERVICES IN THE REORIENT CORRIDOR

Taken together, the economic importance of the REORIENT Corridor, the recent trend toward greater growth in the northbound direction, the current route choices of freight flows between REORIENT countries, and the fact that a proper rail service is missing in the REORIENT Corridor, indicate that it is possible that a new rail service could attract a considerable amount of freight from road to rail-based solutions in the REORIENT Corridor.

5.1. Improvements needed for attracting freight from road to rail

To increase the share of rail-based transport, new rail services for the REORIENT Corridor should be suited to both:

1. Medium to large companies and LSPs for access to stable and large goods repositories.
2. Companies with smaller and not as frequent shipments that today use truck-only transport

For the Medium-big companies one should:

- Improve important quality factors and make prices competitive
- Involve more Logistic Service Providers in managing the medium and small shipments

More active collaboration between railway companies and LSPs could improve service where rail haulage is combined with freight consolidation and/or bulk-breaking operations at both ends. Competitive prices for such services could stimulate small companies to outsource their shipments to LSPs that use rail-based services.

An important finding was, however, that of the today's LCUs carried by truck, 90% can be carried on flatcars (tanks, semi-trailers, swap-bodies and containers on *rail flatcars*). Thus to alleviate barriers hindering small shippers from using rail-based transport, actions should be taken, to:

- Reduce the entry costs by providing flat cars for semi-trailer
- Improve critical and important quality factors
- Provide rail-based consolidation/bulk breaking logistic services

5.2. The REORIENT service concept

Based on statistical and professional knowledge of the current freight flows between REORIENT countries, we have proposed to establish shuttle trains travelling non-stop between terminals (Figure 5.1):

(1) Swinoujscie (Poland)-Bratislava/Vienna
(2) Gdansk/Gdynia-Bratislava/Vienna-Budapest-Thessalonica
(3) Bratislava-Budapest-Constantia

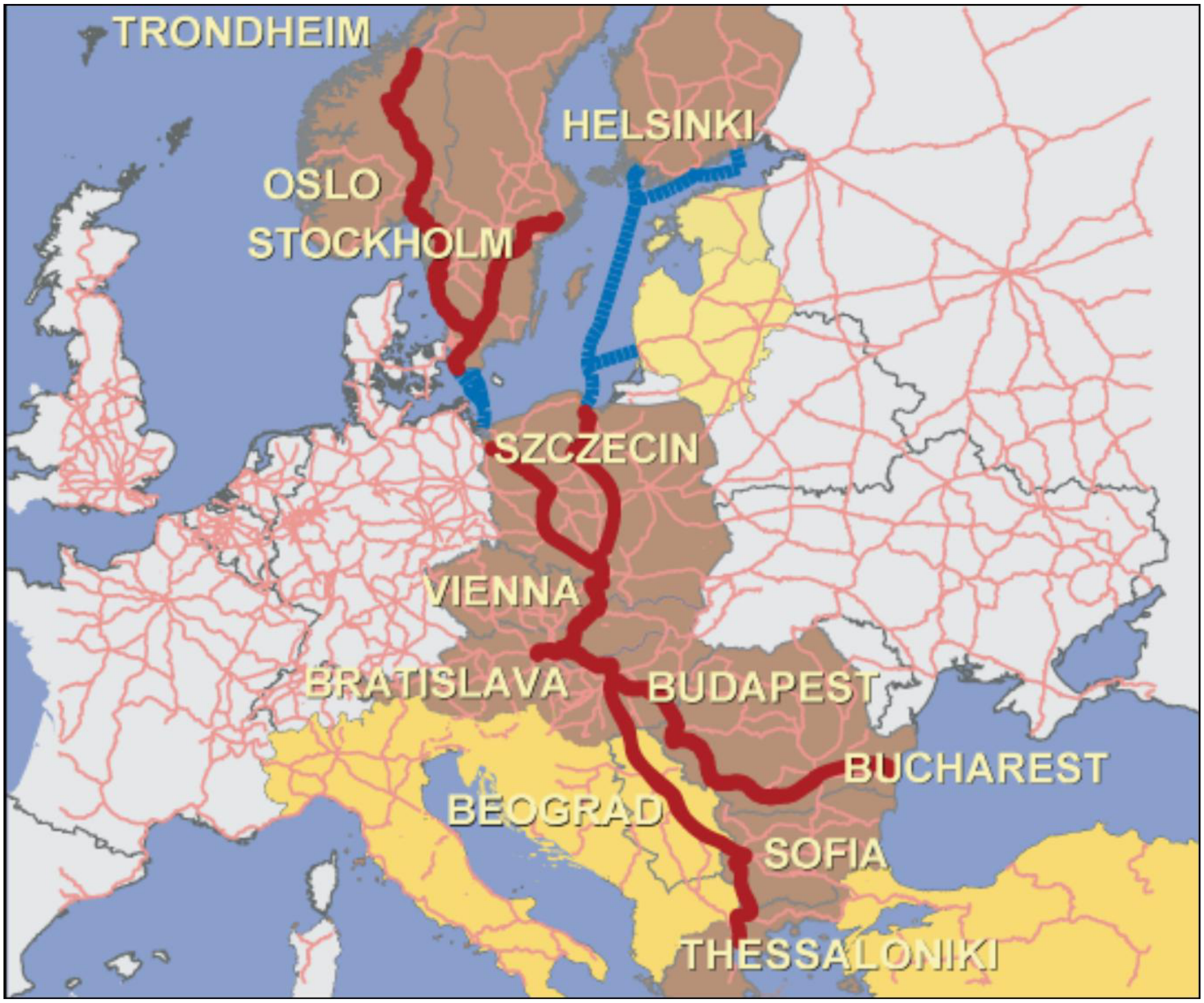

Figure 5.1: REORIENT Corridor and itineraries of the REORIENT service concept.

Moreover, based on the quality factors found important to attract freight shipped by big, medium and small shippers, we suggest that the services on these itineraries should be:

(1) *Swinoujscie-Bratislava/Vienna*: Full Container Load (FCL) block train connecting dedicated to movement of paper rolls.
(2) *Trelleborg-Swinoujscie-Bratislava/Vienna*: Semi-trailer, Swap body on Flat Car (SFC), and full container load (FCL) shuttle train customised to needs of 3 PL and 4 PL providers who buy roundtrips.
(3) *Gdansk/Gdynia-Bratislava/Vienna-Budapest-Beograd-Thessalonica*: Mixed Container on Flat Car (CFC) and SFC shuttle train
(4) *Bratislava-Budapest-Bucharest-Constantia:* Mixed CFC/SFC shuttle train and/or FCL (for unitised bulk). *This service will compete with existing service from Rotterdam.*

6. SHIPPERS MODE CHOICE BASED ON THE TRANSPORT QUALITY

The ranking and factor analysis of 23 quality dimensions underlying the "Desired level of service quality" gave substantial input to development and estimation of models for assessing how shippers' probabilities of mode choices are affected by changes in quality standards of single-modal and intermodal transport in the market for intermodal transport solutions.

A mode choice model represents customer's decision criteria underlying the intermodal and uni-modal freight supply solutions. Ideally the freight mode split model for the REORIENT network model should take into account the causal decision process behind freight mode choices, where a mode isn't an option if certain transport quality requirements aren't satisfied. If the quality requirements are not satisfied, then the mode isn't chosen regardless of the price[29]. For instance we have for fresh degradable food a minimum commercial speed and a minimum temperature is required. We may take this into account by simply using an infinitely low utility for routes of transport solutions that doesn't satisfy the minimum requirements on the specific lanes. On the other hand, as long as we use aggregate commodity groups that consists of commodities with different minimum requirements, we either get a biased model (if we set the minimum to the least demanding commodity within the group) or a model where the mode is unavailable to a part of the commodities despite the minimum requirement is satisfied (e.g., if the average minimum requirement for the commodity group is chosen). Consequently for the REORIENT work we decided not to make explicit representation of minimum requirements. We assume that each decision maker is fully informed about the alternatives (i.e., informed about the attribute values and the alternatives) and is a rational decision maker (i.e., preferences are transitive). Earlier research on modelling freight mode choice models revealed that for a random utility framework, the multinomial logit model structure is the most relevant [30]. Thus, since we assumed that the attributes are commensurate, the attractiveness of an alternative expressed by a vector of attributes values is reducible to a scalar. From this, one can define a single random utility function describing the attraction for a shipment *n*, of an alternative mode $i \in C_n$ in terms of its attributes between a given pair of zones, $U_{in} = V(z_{in}, S_n) + \varepsilon(z_{in}, S_n) = V_{in} + \varepsilon_{in}$. The utility function is founded on the notion of trade-offs, or compensatory offsets, that a decision maker uses to compare different attributes.

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[29] The casual sequence of *decision criteria* of evaluating negotiable and non-negotiable (i.e., fundamental) quality requirements implies there is no point in improving qualities if this will have no effect until other and fundamental quality requirements taken care of.

[30] Earlier work on freight mode choice can be grouped in what Winston (1993) describes as (1) inventory based and (2) behavioural. Behavioural models accounts for the satisfaction of the transport solution but less on firm's possibility of adapting the overall logistics to new transport services offered. Several recent studies applied behavioural models for freight mode choice (e.g., Jiang et al., 1999, Garcia-Menéndez et al. 2004, Lobé 1998, EUFRANET 2001, Fuller et al. 2003 and Ludvigsen 1999). REORIENT focuses on the transport part of the supply chain, which is why the data from the WP6.1 survey primarily describe the transport part of the logistic chain. Based on the REORIENT objectives and the data available for model estimation, we consider the behavioural type of models as the most relevant reference for the purpose of REORIENT. The multinomial logit model formulation is the state of the art modelling technique for this type of models.

Based on the random utility theory, the multinomial logit model is used to express probabilities selecting alternative transport solutions (Ben-Akiva and Lerman, 1985):

$$P_n(i) = \frac{\exp(V_{n_i})}{\sum_{j \in C_n} \exp(V_{n_j})} = \frac{1}{1 + \sum_{j \neq i} \exp(V_{n_j} - V_{n_i})} .$$

For freight mode choice, the utility functions $V_{n,j}$ for the utility of using transport solution j for shipment n. It is a functional relationship with parameters and variables for characteristics of the shipment n and for the transport quality of the transport solution j. It is common to use as parameters estimates, the values that maximise the corresponding log-likelihood function:

$$L = \sum_{n=1}^{N} \sum_{i \in C_n} y_{n,i} \left(V_{n_i} - \ln \sum_{j \in C_n} \exp(V_{n_j}) \right),$$

where $y_{n,i}$ is 1 for the chosen mode for shipment n and zero for other available and possible transport solutions.

To estimate the multinomial logit model we need to assess the value of the utility function for pair of zones with data for typical shipments and thus the level of transport quality for all the transport alternatives $j \in C_n$. The shipper survey contains a total of 425 example routes of typical shipments n with information about the transport quality $x_{n,I}$ for the chosen mode i. But we do not have information about transport quality of the alternative modes that were not used x_{jn}, $j \neq i$. There are also missing values for some transport quality dimensions in some of the records of the chosen mode.

For REORIENT, we used two approaches to circumvent the problem of missing values. The model of the first approach was used to analyse the overall mode shift by unit changes in the level of important quality factors of transport quality per specific mode. The second approach was used to develop a mode choice model that can be used at a disaggregate level as part of the REORIENT network model. The next two sections describe the two approaches. Aggregation of geographical zones could also alleviate the problem of missing data, but was not feasible to accomplish within the time frame of REORIENT and is considered something for future research.

6.1. Effects of isolated changes in the level of transport quality on mode specific shifts

A way to circumvent the problem of missing data is to estimate one separate model for each mode. Each separate model is based on the assumption that the transport qualities of the other modes are fixed. A model of this type is incapable of predicting effects on mode choice if there are changes in the transport quality of several modes simultaneously, but is suitable for analysis of the effect of changes in transport qualities of one of the available modes. The model formulation becomes:

$$P_n(i) = \frac{1}{1 + \sum_{j \notin i} \exp(k_{jn} - V_{n_i})} = \frac{1}{1 + K_{in} \cdot \exp(-V_{n_i})} = \frac{1}{1 + \exp(-V'_{n_i})},$$

where k_{jn} and K_{in} are unknown constants. To estimate the models, we need to make the assumption that K_{in} is the same for all shipments in the sample, i.e. the utility of choosing the alternative modes. Without data for the probability of choosing rail on the different routes, we may assume that the probability of choosing a rail based solution is the same for each route, $\widetilde{P}(i) = P_n(i)$, where $\widetilde{P}(i)$ is set at the share shipments by mode i in the total shipper survey sample, i.e., number of shipments by mode i divided by the total number of shipments. We obtain the logistic model

$$\widetilde{P}(i) = \frac{1}{1 + \exp(-V'_{n_i})} + \varepsilon .$$

Initially we included variables for all service quality dimensions considered important by shippers in the shipper survey in a linear utility function. Additionally, evaluation of shippers' satisfaction with service qualities on the respective routes was included as variables.

For estimation we used data for 383 typical shipments from the shipper's survey that were classified as land-based transport (i.e., shipments with only minor part of the transport route by seaborne transport). The shipments were classified as truck-only in cases where only truck transport were used and as rail-base in cases where rail is part of the transport chain.

The observed survey data were used in SPSS, where data were randomly divided in one data set for estimating the logistic regression (70% of sample) model and another which is used to validate the results internal in the algorithm (30%). Separate models were estimated for truck-only and rail-based modes for each SITC-1 commodity group. In the final step of the iterative algorithm for estimation by maximum likelihood, the fit between the model predictions for road and rail collectively reached 86 percent (i.e., Model probabilities above 50% for the corresponding mode chosen in the survey was interpreted as fit). The model fit for truck choices was correct for 97 percent of road shipments in data set. Rail was more difficult transport choice to predict than road. Model-data accuracy for rail choices was only 41 percent. Goods volumes, and transit speed for commodity SITC-6 and SITC-7, and satisfaction score of reliability were the only significant variables.

The model was used to test the sensitivity of rail- vs. road probability distribution on improvements of service qualities which proved important in the preceding analyses.

The odds of rail choice for a shipment are related to probability by: $Odds(RAIL) = \frac{P(RAIL)}{1 - P(RAIL)}$. We used ratio-changes in odds to analyse probabilities of mode shift to rail versus truck for defined changes in significant model variables (Table 6.1).

Table 6.1: Defined units of explanatory variables and odds ratio-change, for rail per unit change in the logistic regression model for the probability of rail

Variable	Unit	Odds-ratio change
Goods volume yearly shipped by respondent on	1,000 tons	1.135
Transit speed for SITC6 (semi finished goods)	1 km/h	1.333
Transit speed for SITC7 (machinery, technical	5 km/h	1.295
Satisfaction score (1-5) on Reliability of	1 point	2.080

Odds-ratio factors of above 1.0 imply that the probability of choosing rail on shipment routes is expected to rise with an increase/growth in the value levels of the model variables. An assumption of increase in volume of yearly freight shipped by 1,000 tons is probably not unlikely for some large shippers in the South-eastern Europe with fast-growing markets for international freight transport.

The models were used to predict changes in probabilities for shippers' choices of rail for shipments of the five main goods categories obtained from runs of the baseline and three scenarios, where the baseline included current values of explanatory prediction factors (Figure 6.1). The latter affects two commodity categories.

The effect of speed movement improvement by 5 km/h increases the probability of choosing rail for supply of the main SITC categories, semi-finished products (SITC 6) and machinery/technical equipment (SITC 7), whilst other cargo categories are not significantly affected. A one-point rise in satisfaction with reliability of rail service achieved the highest odds of mode change. Moderate option indicates that considerable mode shifts are possible in regions/corridors with potentials for higher service reliability. This is a reasonable result because by and large rail is still cheaper than truck as regards transfer of some processed commodities, provided of course, that rail could meet other related requirements.

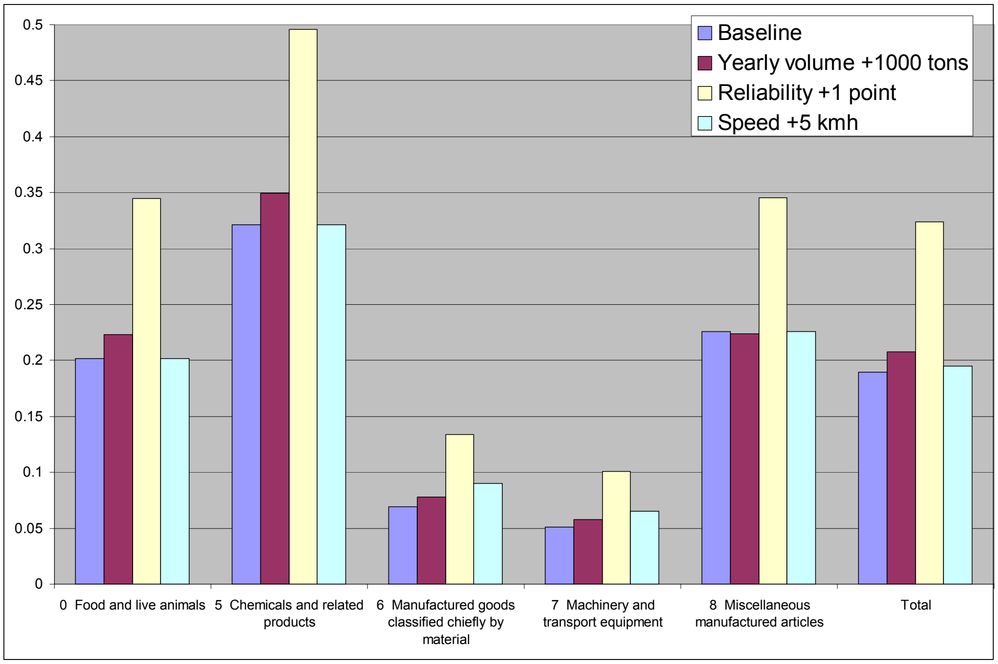

Figure 6.1: Probability of choosing rail by shippers of five goods categories in four scenarios

6.2. Multinomial mode split model for the REORIENT network model

In this section we present the binary logit model considering truck-only and rail-based alternatives that was developed for direct integration with the REORIENT network platform to allow for the evaluation of the effects that alternative strategies and policy scenarios have on the mode shift. Also, an extended and nested version is presented that incorporates implicit differences in shippers' choice to ship by land (e.g., by truck-only or rail-based alternatives) or by sea/air (e.g., by the "others" alternative).

6.2.1. Model specification

Initially we considered developing a mode choice model for only one type of commodity that is characteristic for the market for intermodal transport solutions. General cargo is the dominant ETIS manifestation type of the shipper survey typical shipments that are representative for this market. However, because general cargo is a diverse commodity type, because there are small shares of other commodity groups within the segment, and because of consistency with the network models, we decided to estimate a mode choice model that takes into account the type of commodity by NST/R 11 classification.

The utility per mode alternative in the network model is decomposed into the following systematic components:

$$V_{n_i} = V_n + V_{n_i} + V'_{n_i}$$

where, V_n is the portion of the utility associated with characteristics of the shipment, V_{ni} is the portion of the utility associated with alternative i, V'_{ni} is the portion of the utility that results from the interaction between alternative i and shipment n.

It is assumed there are inherent perceptual differences in the decision-maker's choice process when considering the land-based alternatives truck-only and rail-based versus sea- and air-based. To take this into account, we specify a nested logit model that considers a two-dimensional choice of geographical context (e.g., land and sea/air) and mode of transport (Figure 6.2).

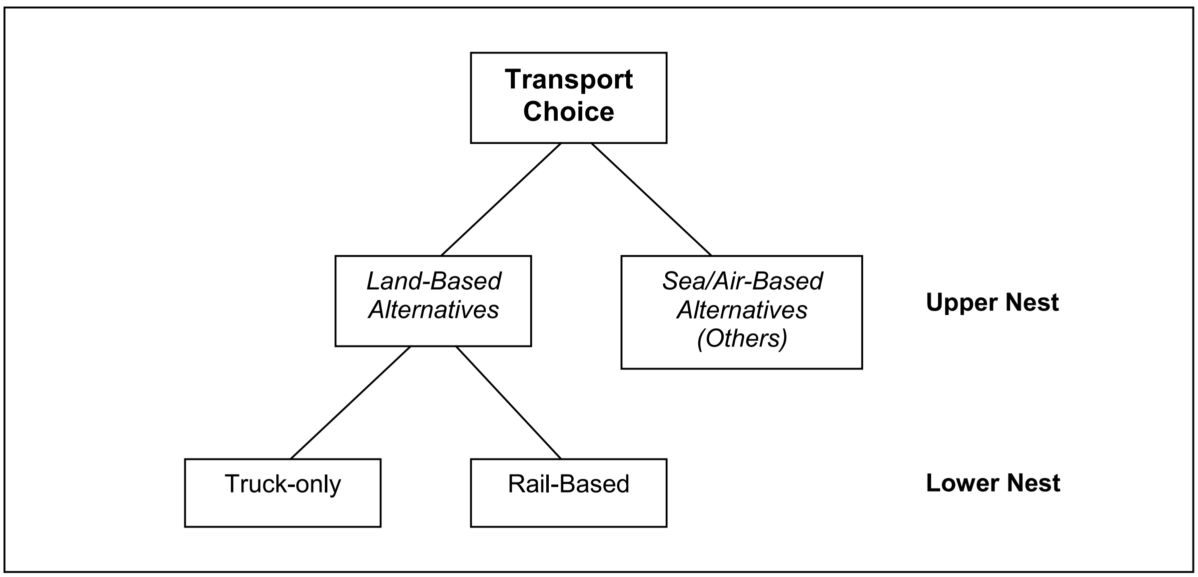

Figure 6.2: Nested Structure of Choice Dimensions

The variables of transport quality and shipment characteristics that can be included in the mode choice model for the REORIENT network model are restricted to the corresponding attributes available in the network model. With the REORIENT network model, it isn't possible to take into account any changes in reliability, which were identified as significant variables for mode choice decisions in the first approach (Section 6.1).

To specify the systematic components, we used a linear functional relationship linear in the parameters. Utility specification of the lower nest for differences between truck-only and rail-based alternatives was specified to fit with the attributes that can be modelled in the network model (Table 6.5). At the upper nest level (Table 6.6), we also incorporate attributes that are common to land-based alternatives, sea-based alternatives, or both (e.g., border time, terminal time, long distance, and building material).

Due to scarcity of data for some of the commodity groups, the model structure was formulated such that parameter estimates for some dimensions of transport quality were common for several modes and commodities. The alternative specific constants β_1 capture such variables that we cannot vary in the network model, like reliability and damage and shipment size. Interaction terms between shipment characteristics and transport quality were used to alleviate the drawback that the same parameter estimates are used for several commodity groups. Still, however, common parameter estimates are more representative for the commodities that are well represented in the data set. Weighting of data is an option to correct for this, but would reduce the representativeness of the model for those commodity groups that are most important within the market for intermodal transport solutions.

Table 6.5: Utility Specification for Lower Nest

	β_1	β_{21}	β_{22}	β_3	β_4	β_5
U_{Truck}	0	$travel\ time \times (travel\ time < 70) \times \frac{value}{ton}$	0	$travel\ time \times (travel\ time \geq 70) \times \frac{value}{ton}$	$\frac{price}{value}$	
U_{Rail}	1	0	$travel\ time \times (travel\ time < 70) \times \frac{value}{ton}$	$travel\ time \times (travel\ time \geq 70) \times \frac{value}{ton}$	$\frac{price}{value}$	$hazard$

Table 6.6: Utility Specification for Upper Nest

	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
U_{Land}	0	0	0	0	$border\ time$	$terminal\ time$	$long\ distance$	$building\ material$
U_{Sea}	1	$travel\ time \times (travel\ time < 70) \times \frac{value}{ton}$	$travel\ time \times (travel\ time \geq 70) \times \frac{value}{ton}$	$\frac{price}{value}$	0	$terminal\ time$	0	0

6.2.2. Method for dealing with missing values

For the network model, it was important to retain the logit structure, which makes it possible to predict mode shifts with respect to possible changes in the level of quality factors for several modes simultaneously at a disaggregate level. In order to estimate a disaggregate mode choice model based on the logit structure, it was necessary to establish data for cases of observed mode choice and data for corresponding variables for antecedent and independent variables in the utility function for all available transport solutions with sufficient transport quality.

From the total of 425 typical shipments in the shipper survey, we prepared a data set in which we excluded 27 typical shipments from Lithuania, 3 truck-only shipments to distant destinations across the Ural Mountains in Russia, and 1 airborne transport. The transport solution used for the typical shipments were classified as truck-only, rail-based, or other, where truck-only transport comprise shipments defined as single modal truck-shipments, rail-based were used for those shipments where rail transport was part of the transport chain, and other transport for the remaining, i.e., essentially those shipments with no rail and ship as part of the transport chain[31].

The shipper survey data contain observations of mode choice and antecedent variables that describe the shipment, but only data for elements of observed transport quality of the chosen transport solution. In some cases there are also missing data for elements of quality for the chosen transport solution. For the estimation of the logit model we need, however, data for the variables representing quality factors in the utility functions of both the chosen and the un-chosen modes.

To complete the shipper survey data, we developed an instrument to replace the missing data for quality factors for the un-chosen mode. We considered only quantitative quality factors, since there were no variables in the network model corresponding to shipper survey data for qualitative factors.

The instrument was developed in terms of one prediction model for each type of transport quality dimension k and mode i,

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where xxx are data from the shipper survey for the levels of transport quality of typical shipment n with chosen mode i and xxx is a vector of parameters for corresponding predictor variables. Candidates of predictor variables may represent characteristics of the shipment lanes of the cases n. Distance is a characteristic that is correlated with several quality factors of the shipment lanes. We used GIS tools established in the REORIENT project to estimate the distance as the distance by road between NUTS zones of origin and destination of all shipment lanes n. We also included variables for the shares of truck-only, rail-based, and other transport solutions of the flows between origins and destinations of the shipment lanes ($P(T)$, $P(R)$ and $P(O)$). Data for these variables were obtained from ETIS-Base. The typical shipments were classified by NST/R 11 commodity groups. We formulated functional forms of the instruments that represented the extracted ETIS probabilities and distance by road between geographical zones as independent variables. One function per quality dimension and

[31] The shipper could select among truck, rail, ferry intermodal, ferry single modal, deep sea vessel and air freight. From these alternatives the following transport chains were choosen: (1) Truck, (2) Rail, (3) Truck+RoRo (IM), (4) Truck+RoRo (UM), (5) Truck+Rail, (6) Truck+Ship, (7) Rail+Ship, (9) Truck+Air, (10) Truck+RoRo (UM)+Rail, (11) Rail+Railferry, (12) Ship, (13) Truck+RoRo (IM)+Rail, (14) Rail+Ship+Truck, (15) Air, (16) Ferry+Ship. We consider shipments by (1), (3) and (4) as truck-only shipments, (2), (5), (7), (10), (11), (13) and (14) as rail-based shipments and (6), (9), (12), (15) and (16) as shipments by other transport.

mode was required, and to ensure that there are non-negative values throughout the imputed data set, we took the log of all values in the following functional forms of instruments for truck-only, rail-based, and other transport solutions:

xxxxxxxxx

where T denotes truck-only, R denotes rail-based, and O denotes other transport solutions. We assume regression of these instruments follows general ordinary least squares principles, mainly: (1) the specification is linear and the functional form is correct; (2) the error term has a mean of zero; (3) errors for different observations have the same variance; (4) the errors for different observations are not correlated; and (5) the probability parameters/ variables remain fixed in repeated sampling. In the literature the instrument variables xxxxxx are commonly referred to as 2SLS estimates that are statistically consistent. We estimated the instrument for the following dimensions of transport quality[32]:

1. Travel Time (hr) (TT)
2. Transport price (€) (TC)
3. Booking Time (hr) (BK)
4. Number of Tracking and Tracing Facilities (FC)
5. Value per tonne
6. Probability of Delay (% of shipments) (DL)
7. Probability of Damage (% of shipments) (DM)
8. Transport price per Tonne (€ /tonne) (CPT)
9. Harbor Time (hr) (HT)
10. Border Time (hr) (BT)
11. Storage Time (hr) (ST)
12. Terminal Time (hr) (TM)

and for the shipment specific characteristics:

1. Frequency (Freq)
2. Weight of shipment (Tonnes) (WS)
3. Volume of shipment (cubic meters) (VS)
4. Value of shipment (€/tonne) (VAL)

[32] For completeness we estimated the instrument for all variables for which there is quantitative data in the REORIENT shipper survey, but only variables corresponding to attributes in the network model were used in the mode choice model estimation (see section 6.2.4)

5. Hazardeous (0 or 1) (HAZ)

There were 117 observations with either an ETIS probability of 1.0 in one mode (probability of 0 for the other two modes) or ETIS probabilities of 0.5 and 0.5 in two modes (and 0 in the third). These observations were not included in the instrument regression, but when re-introducing those observations for the imputation, the imputed values were frequently negative and inconsistent with chosen alternative attributes, most likely due to the multicollinearity of the alternatives. For cases with ETIS probabilities of 1.0, we removed them from the data set, as this implies that the shipper would always choose the current alternative. For cases where including two probabilities lead to multicollinearity (i.e., the sum of the two probabilities is 1.0), the regression includes only one probability. Following the removal of cases where ETIS probabilities were 1.0 for the chosen mode, there were 318 cases remaining.

6.2.3. Data description

In our survey sample, 63.52% of the shipments are by a truck-only transport service, 24.53% by a rail-based service, and 11.95% chose to ship using either a ship-based or an air-based service (Table 6.3). In tonnes, however, rail-based solutions dominate the survey sample because of large shipment sizes (see Section 2.4). Of shipments travelling greater than 2,000 kilometres, approximately half (48.28%) are carried by truck. No hazardous shipments are conveyed by other-based service, which support the hypothesis that truck and rail alternatives are correlated (by certain “land” characteristics) and are perceived differently than the other alternatives.

Conforming to expectation, a large majority of shippers (78.79%) ship using a truck-only service for shipments defined as high valued goods (i.e., shipments having a value per tonne of greater than €20,000). The latter is consistent with data from ETIS-Base (see Section 4.2.1), where we found that within the general cargo segments the composite carried by truck is generally more valuable than the composite carried by rail.

Table 6.3: Descriptive Statistics for Indicator Variables (i.e., variables either taking the value 0 or 1)[1]

PARAMETERS	Transport Mode Alternatives					
	Truck-Based		Rail-Based		Others	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Chosen Mode *(1 if mode was chosen, 0 otherwise)*	202	63.52%	78	24.53%	38	11.95%
Hazard *(1 if shipment is hazardous, 0 otherwise)*	21	36.84%	36	63.16%	0	0.00%
Long Distance *(1 if total distance is > 2000 km, 0 otherwise)*	84	48.28%	48	27.59%	42	24.14%
High Value *(1 if value/ton > 20000, 0 otherwise)*	78	78.79%	9	9.09%	12	12.12%

[1] Based on only real survey responses

To limit the number of mode and commodity specific parameters, we used transformed level-of-service variables (Table 6.4).

A greater transport price per unit value of the goods for rail implies that cargo carried by rail have in general a lower density value than goods carried by truck.

The effect of travel times was found to be non-linear. To account for this in a linear model we chose to specify a piecewise linear travel time by value per tonne parameter that has a parameter for observations below a time threshold and another parameter for observations above that threshold. By inspection of the travel times in accumulating order, we found that a threshold of 70 hours was appropriate. Besides, we cannot directly infer that the mode choice is indifferent to the commodity value per tonne. To also account for this without introducing extra parameters, we represented interaction terms for travel time and value per tonne within low and high travel time categories.

For the truck alternative, it is interesting to note the high value per tonne for the high travel times. It may be that for long distance high-value shipments travel time is more critical and that rail is less often capable of providing sufficiently fast service. Despite the high value per tonne, the average high travel time by value per tonne is similar to the low travel time category, which means that most of these observations have travel times just above 70 hours. It is also interesting to note that for rail, the low travel time by value per tonne is much greater than the high travel time by value per tonne (339,503 hr-€/tonne vs. 119,430 hr-€/tonne, respectively). When looking at the value per tonne of the shipments segmented by low and high travel time, the average value per tonne for travel times less than 70 hours is greater for rail than for truck. The rail shipments in the high travel time category are of low value. For the others alternative, the low travel time by value per tonne is similar to truck, but high travel time by value per tonne is much greater.

Table 6.4: Descriptive Statistics for Transformed Level-of-service Variables[1]

PARAMETERS	Transport Mode Alternatives					
	Truck-Based		Rail-Based		Others	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
LOS INTERACTIONS *(with shipment-specific variables)*						
Speed (km/hr) *(Total distance divided by travel time)*	11.875	23.125	7.443	15.354	4.263	11.221
Price per ton/ Value per ton *(Intends to capture commodity effects)*	0.022	0.166	0.115	0.870	0.136	1.283
Low Travel Time x Value/ ton *(For travel time < 70 hours)*	175767.2	2110339	339503.2	4182498	155862.4	3294682
High Travel Time x Value/ ton *(For travel time ≥ 70 hours)*	178464.8	2839484	119429.7	1911343	532534.1	4150727
Value/ ton *(For travel time < 70 hours)*	20779.51	141623.9	28738.62	162127.7	86145.54	342781.1
Value/ ton *(For travel time ≥ 70 hours)*	42208.31	146327.8	12229.31	71669.54	14036.73	65490.77

[1] Based on both real survey responses and imputed values

6.2.4. Model estimation

With missing levels of transport quality replaced by imputed values ($\tilde{x}_{ink}$), we used maximum likelihood in LIMDEP to simultaneously estimate the linear-in-parameters utility function for each mode.

For the binary logit model considering only truck and rail alternatives, the model rejects 38 cases in which the shippers chose the 'others' alternative, resulting in 280 remaining observations in the estimation (Table 6.7). The alternative-specific constant for rail is negative, which implies that holding all other attributes constant (e.g., travel time, price), shippers prefer the truck-only alternative over rail-based alternatives.

The parameter estimate for the interaction between travel time and the value per tonne implies that the higher the value per tonne of the shipment, the more sensitive the shipper is to travel time. Travel time is one of the highly ranked quality dimensions that also have a large discrepancy between shippers' ranking of importance and satisfaction (see Section 3.1). Below 70 hours of travel time, we find that rail is more negatively affected than truck by an increase in this interaction term. To explain this, one needs to realise that the type of shipments modelled are primarily in the general cargo segment, which are overall of high-value and thus of relatively high priority. While on average the rail-based solution takes a longer time than truck, it is a higher probability for rail than for truck that a unit increase in lead time or value leads to transport quality below the critical level where the mode isn't an alternative.

Above 70 hours, truck and rail alternatives are equally, negatively affected by increases in travel time; however, it is not significant at the 80% level. It is reasonable to believe that shippers perceive travel time indifferently above a certain level, since it will take a long time no matter what service they choose, and therefore land-based transport with lead time above 70 hours is primarily used for shipments that are less sensitive to increases in lead time.

Since shippers pay upfront out-of-pocket costs for transport services regardless of mode, it is reasonable to assume that an increase in unit price will be perceived to be equally onerous across alternatives. Thus, for the truck- and rail-based alternatives, we used a common estimate for the parameter corresponding to the model variable of price over value. We divide price per tonne by value per tonne (thus cancelling the tonnes) to again account for commodity effects. This formulation implies that as the value of the shipment increases, the shipper will be less sensitive to the price of shipping the good. It is synonymous with cost divided by income formulations seen in the literature regarding urban mode choice models. As expected, the coefficient is negative, meaning the higher the price, the less likely the shipper will choose to ship by a mode.

Finally, an indicator for hazardous shipments in the utility for rail has a positive coefficient. This means that if a shipment is hazardous, it will increase the likelihood of a shipper choosing rail when compared to truck. This is reasonable since rail has fewer accidents (i.e., derailments) than trucks; shippers may perceive rail to be a safe mode for hazardous material transport.

Table 6.7: Estimation results for the Binary Logit Model of Mode Choice for Network Platform

	Transport Mode Alternatives			
	Truck-Based		Rail-Based	
Variable	Coeff.	Std. Err.	Coeff.	Std. Err.
Alternative Specific Constant				
Rail			-0.5215	0.2105*
LOS Attributes				
Low Travel Time (Travel Time < 70 hrs) x value/ton	-3.038E-06	1.337E-06*	-4.616E-06	1.289E-06**
High Travel Time (Travel Time ≥ 70 hrs) x value/ton	-2.151E-07	3.949E-07	-2.151E-07	3.949E-07
Price per ton/ Value per ton	-1.8411	1.0094	-1.8411	1.0094
Indicator Variables				
Hazard			1.6001	0.5702**
Log-likelihood for constants only	-165.648			
Log-likelihood at convergence	-136.683			
ρ^2	0.2803			
Number of observations	280			

Level of significance: All greater than 80%, * > 95%, ** > 99%
Coefficients that weren't significant at the 80% level were restricted to zero and omitted from the table.
Exception is high travel time x value/ton, network platform needs a value of travel time for all values of time.

To estimate the nested logit model, we used a sequential estimation procedure in LIMDEP that first estimates the conditional model (the binary logit model), calculates a logsum term, and then estimates the full model with the logsum. Estimation results are presented in Table 6.8.

The alternative-specific constant for others is negative, and also is more negative than rail, which implies that holding all other attributes constant (e.g., travel time, price), shippers prefer the land-based alternative over the others-based alternative.

It is a greater negative effect of an increase in travel time for the other mode than for the land based mode for travel time up to 70 hours. This implies that the other mode is closer than the land based alternative to the critical levels, where the mode isn't an alternative any more if travel time increases. It is not significant at the 80% level, however. This implies that travel time is not relevant for shippers choice between land-based and other mode for total travel time below 70 hours. As mentioned before, the interaction with value per tonne accounts for commodity effects.

Also, for travel time 70 hours and above, the negative effect of an increase in travel time is greater for the others-based alternatives. Shippers may begin to perceive travel time differences in this range for others-based alternatives, thus increasing the sensitivity to changes in travel time. The higher the value per tonne of the shipment, the more sensitive the shipper will be to increases in travel time.

Two additional time components were evaluated in the upper nest of the model – border time and terminal time. Statistics for the booking time, border time, and terminal time have similar values for truck and rail, but significantly different values for the 'others' alternative, supporting the argument that there is a perceived difference between shipping by land and by sea. Border time was very insignificant for the others-based alternative, which follows logic since ships and airplanes generally have only waiting and processing time at the beginning and the end of the trip, and thus it isn't as relevant as for truck and rail-based alternatives, where delays at these border stations are experienced as they travel from one country to another. Increasing terminal time equally decreases the likelihood of choosing any mode, although it is not significant at the 80% level. This indifference towards terminal processing times stems from the fact that these times are inevitable no matter which alternative is chosen (similar to high travel time for land-based alternatives).

If a shipment needs to travel more than 2,000 km to reach its final destination, it is considered a long distance trip, and it decreases the likelihood of taking a land-based alternative (i.e., it equally decreases the likelihood of taking truck or rail) relative to the others-based alternative. This result may be capturing a trade-off between traversing long distances quickly via plane (and consequently paying a higher price), or traversing long distances slowly via ship (and consequently incurring a very high travel time a low price).

Finally, if a shipment has a commodity designation of NST/R 5 or NST/R 6 (goods considered building materials), it increases the likelihood of choosing a land-based alternative relative to the others-based alternative. This is reasonable since these materials are usually not high enough in priority, and not small enough, to be placed in a cargo plane, and are valued enough to not be the goods on a slow-moving ship.

Table 6.8: Estimation results for the Nested Logit Model of Shippers Mode Choice

	Transport Mode Alternatives					
	Truck-Based		*Rail-Based*		*Others*	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Alternative Specific Constant			***-0.5215***	***0.2105****	-1.8077	0.3545**
LOS Attributes						
Low Travel Time (Travel Time < 70 hrs) x value/ton	***-3.038E-06***	***1.337E-06****	***-4.616E-06***	***1.289E-06*****	-2.371E-08	8.400E-08^
High Travel Time (Travel Time ≥ 70 hrs) x value/ton	***-2.151E-07***	***3.949E-07^***	***-2.151E-07***	***3.949E-07^***	-6.106E-07	3.358E-07
Price per ton/ Value per ton	***-1.8411***	***1.0094***	***-1.8411***	***1.0094***	-0.3564	0.5027^
Border Time (hrs)	-0.0357	0.0234	-0.0357	0.0234		
Terminal Time (hrs)	-0.0029	0.0039^	-0.0029	0.0039^	-0.0029	0.0039^
Indicator Variables						
Shipment is hazardous			1.6001	0.5702**		
Long distance shipment (1 if shipment travels >2000 km)	-0.9189	0.4123*	-0.9189	0.4123*		
Shipment is building material (1 if shipment is NST/R 5 or NST/R 6)	1.3446	0.7550	1.3446	0.7550		
Logsum Term	0.1865	0.1559	0.1865	0.1559		
Log-likelihood for constants only	-282.011					
Log-likelihood at convergence	-233.715					
ρ^2	0.4403					
Number of observations	318					

Level of significance: All greater than 80%, * > 95%, ** > 99%
Coefficients that weren't significant at the 80% level were restricted to zero and omitted from the table.
^ Denotes that the parameter estimate is not significant at the 80% level, but is of noteworthy interest to this research.
Bold-italicized indicates lower-nest estimates used in the REORIENT network platform

7. CONCLUSION

From in-depth analysis of data from the REORIENT shipper survey, we found that:
(1) Rail shipments are big and primarily shipped by big shippers,
(2) The numerous small shippers have a relatively low rail share,
(3) Manufactured goods (general cargo) is the major commodity group in the market for intermodal services,
(4) Rail-based transport is cheaper than truck for the major commodity groups.

Based on official statistics primarily from ETIS-Base, foreign trade statistics and projections in growth of the demand for transport between corridor countries of commodity groups relevant for rail-based transport, we found there is potential for new rail services in the REORIENT Corridor to attract considerable amount of freight from road to rail-based conveyance.

For medium to big companies, we identified that improvements to attract more freight from road to rail would be to improve highly ranked quality factors with significant gaps between shippers' ranking of importance and current satisfaction with the services. It is still important to ensure competitive prices. To broaden rail-based services' competitive interface with truck-only transport, the service quality needs to be improved sufficiently that rail-based transport becomes an alternative mode for carriage of the numerous small shipments for small shippers that today are primarily carried by road-only transport. Essential in this regard are the Logistic Service Providers as a link for the consolidation and bulk-breaking. Their presence and effective and efficient performance are necessary for cost effective distribution of small shipments.

The value of goods conveyed by truck is overall of greater value than goods conveyed by rail-based transport solutions. For rail to broaden its market also to segments that today are primarily served by truck-only transport, it is important to increase transport quality, especially in dimensions where there is a large discrepancy between the importance and satisfaction with transport quality and where the current quality standard on rail-based solutions is below critical levels for rail to be a possible alternative to road-only transport.

Two approaches to mode choice analysis based on random utility theory identified that the shippers' mode choice decision is significantly sensitive to reliability, transit time, and speed, and that the sensitivity depends on the type of commodity, and the length and duration of shipments. For travel time, there is a large discrepancy between importance and satisfaction for shipments by rail-based transport. As a consequence, we found that a unit increase in transit time affects rail more negatively than truck, and thus there is a greater probability for rail than for truck that an increase in transit time leads to transport quality below the critical level at which the mode isn't an alternative any more.

By improving the service quality it could also be possible for rail-based solutions to compete more fiercely directly in the market for shipments of single LCUs. Three types of LCUs dominate rail transit in the countries analyzed: 20-foot containers, 40-foot containers, and swap-bodies. This indicates that rail may capitalize on its inherent competitive advantage in door-to-door segments and intermodal chains. Semi-trailers on flat cars is also a potential market if a sufficient rail service is established. We have embedded the identified factors for attracting freight from road to rail-based solutions in a set of suggested rail shuttle services in the REORIENT Corridor.

APPENDIX A: INTERMODAL TRANSPORT IN THE REORIENT CORRIDOR

In a historic perspective, separate developments of transport infrastructure were primarily built to serve national needs and standards in different parts of the corridor. This has led to barriers that affect the quality of international rail transport. Parts of the existing national rail networks are also in a poor condition because of insufficient financial resources for maintenance and development. On the positive side, there is surplus capacity along existing itineraries in the corridor and some upgrade of these itineraries could increase the commercial speed and competitiveness of new rail services. Measures related to infrastructure charges and reductions in various types of barriers may also increase the competitiveness.

For Norwegian and Swedish trade with other REORIENT countries there are important railway lines from Oslo and from Halsberg in Sweden. Trade flows by road and rail are primarily moved through Sweden to Göthenburg and Malmö. In Malmö there is transshipment for further shipment from main ports of Ystad, Trelleborg and Karlskrona in Southern Sweden for transport from and to Norway and Sweden to Germany, Poland and other European ports.

Of the Polish ports, the port of Gdynia is the main intermodal terminal, but although there are no facilities for handling intermodal units in Swinoujscie, we have information that sea-rail connections can be established in several ways. The rail ferry service between Ystad and Swinouitze is the only sea route offering transport of railway wagons between Norway/Sweden and Poland. Currently the existing ferry terminal in Swinoujscie does not have facilities for handling intermodal units, but the big intermodal terminal in Gdynia serves container shipping from Helsingborg, Norrkøping, Stockholm and Uddevalla in Southern Sweden. There are also shipping routes from eight ports in Norway to Swinouitze and Gdynia. From Finland there is the possibility of shipment to for instance Stockholm and from Stockholm to Halsberg and onwards. From Finland there is also the option of shipments from Helsinki, Turku, Kotka and Hamina to the intermodal port of Gdynia.

But a new ro-ro and train ferry operation is planned between Trelleborg and Swinoujscie from late 2007. Leder et al. (2005) find Trelleborg to be the leading ro-ro port in Sweden. Their “Vision 2005” foresees the need to double the handling capacity of the intermodal terminal and build two new ferry berths with rail connection. The intermodal terminal in Gdynia is the most important Polish port for transport between Finland and Poland, and Finland ship 55% of all tonnes of general cargo (60% in value) from the Nordic countries. Gdynia also attracts some freight via shipping lines from Sweden and Norway. Based on Eurostat and Polish port statistics for year 2004, we find the general cargo share of total port turnover is 64% in Gdynia and only 4.5%, 16% and 11% in Swinoujscie, Szczecin and Gdansk (see also Table A1.1). It is evident that the intermodal port in Gdynia is the most important for expedition of the general cargo commodity. Terminal investments were made in Gdansk and Gdynia port hubs – for Finnish paper industry to central Europe. From the ports in northern Poland, freight is shipped by rail or truck southward in the corridor for final destination in Poland or in transit to other corridor countries or to the hinterland and vice versa in the opposite direction.

Table A1.1. Total turnover in Polish ports and the %-ages of general cargo and coal (based on Eurostat and Polish port statistics[2] for year 2004)

	Million tonnes	*General cargo*[2]	*Coal*
Swinoujscie	10	4.5%	60%
Szczecin	9	16%	53%
Gdansk	21	11%	75%[1]
Gdynia	11	64%	10%

[1] liquid bulk and coal
[2] To obtain numbers specifically for the %-age of general cargo we used information on internet sites for the respective ports: http://www.phs.com.pl, http://www.bulkcargo.com.pl/ang/statistics/cargo.htm, http://www.port.gdansk.pl, http://www.port.gdynia.pl,

Extra capacities have built up in the Polish railway network in part as a consequence of decreasing international railway transport during the last decade and in part because of inherent capacity increase. Intermodal transport is utilising some of the surplus capacity but does not surpass about 2% of general mass of transported loads of railway transport. Intermodal transport is mainly the effect of claim of foreign trade partners (participants: PKP CARGO S.A, Spedcont, Polcont, Polzug, Trade Trans, Cargosped and also sea ports such as Baltic container terminal, in the port of Gdynia). But intermodal transport is the fastest developing segment. In a note by Korecki, J. (Baltic container Lines Co. Ltd., Gdynia) out of the 660000 TEU of the Polish market for international container transport in 2003, about 350 000 TEU are handled in Polish ports and 310 000 TEU in ports of Western Europe (Hamburg, Bremerhaven and Rotterdam). It is estimated that 800 000 TEUs were shipped to and from Poland in 2005 - about 450 000 in transit and shipped on from Gdynia, Gdansk and Szczecin. These estimates are similar to a statement by the Interreg project ECO4LOG (2005), who says currently some 55% of Poland’s containerised import and export flows are carried by road and rail (Operators: Polzug and ERS) to the ports in the North Sea range. The leader of international market of railway transport of containers is Polzug Intermodal GmbH – common venture: PKP Cargo SA, Stinnes AG, HHLA Hamburg Port and Logistics AG. In 2005 result of this joint venture - amount to 75 000 TEU. Kombiverkehr, ERS, Pulzug and Intercontainer all have shuttle services to and from Poland and other Central and South-Eastern European countries.

Important intermodal hubs are located in Bratislava and Vienna. Slovak container transport has increased strongly by 650% since 1994, where transport by ISO-container is 99% of intermodal transport. Of the 1245 thousand tonnes of Slovak intermodal transport in 2005, 27 were domestic, 388 were export, 436 were import and 395 were transit traffic, i.e., national combined transport is rare**.** Most is overseas transport via Bratislava, Zilina, and Dobra (largest). The new car manufacturing and related industries are using the intermodal services. The rail share of Austrian import/export flows in 2003 was 40%, and specifically the rail share in Austrian trade with CEE countries was 58% and 80%.

Czech Republic is an important transit county and combined transport was mentioned for the first time in Czech national transport policy in 1998 and investments have been financially supported. Total freight traffic in tonnes carried in 2005 was 85 million tonnes of which 52 million tonnes were international freight traffic. Total Czech transport volumes of large containers increased between 2003 to 2005 by 27%, from approximately 4 million to 5 million tonnes. But this was at the expense of a decline of heavy goods vehicles on rail from 3 million tonnes in 2003 to none in 2005.

Budapest in Hungary has an intermodal terminal but only overseas (Asia/America) Hungarian cargo is transported intermodally, both in import and export relations (i.e., consumer goods and industrial parts in both directions). Total rail freight traffic in Hungary in 2004 was 8,311 million tkm, which is 28% in the modal split. The ratio of intermodal rail operations to the total rail volume is 10%, so intermodal rail operations are 2.8 % in the modal split. Intermodal freight in 2004 has carried 5.1 million tons of goods in 303 400 ILU's. Hungarian forwarders use deep-sea harbours in Hamburg, Coper (SLO) and Thessaloniki (GR). Rotterdam is of lesser preference than Hamburg. Only the largest logistic companies such as MAERSK Line and specialised firms have intermodal expertise and significant market share. There are 120 intermodal shuttle trains weekly to 15 destinations. Continental traffic is single modal, mostly road only and sometimes rail-only.

From Budapest, there are rail connections to hubs in Bucuresti and Constanca in Romania. There is also a rail connection from Budapest to Beograd and further down to Thessaloniki.

APPENDIX B: SEGMENTATION OF SHIPMENTS IN THE REORIENT CORRIDOR

We used conversion tables provided by NEA for converting the WP6.1 data by SITC commodity group to ETIS-Base Manifest commodity types. By looking at the segmentation of the WP6.1 typical shipments by both the Manifestation and SITC commodity grouping (Table B1.1), we find that the SITC commodity groups 0, 1, 5, 7, 8 are totally or primarily in the general cargo segment. SITC group 6 is also well represented in semi-bulk and dry-bulk. The SITC groups in the general cargo segment are primarily consumables and to a lesser extent pre-fabricates.

Table B1.1: The WP6.1 survey truck+rail sample. Number of observations in the two commodity classification code systems

		SITC1 main chapters									
Mode of		**0**	**1**	**2**	**3**	**5**	**6**	**7**	**8**	**Total**	**Percent**
appearance	**General Cargo**	22	7	0	0	38	58	68	59	252	66 %
	Liquid Bulk	0	0	0	12	0	0	0	0	12	3 %
	Semi-Bulk	4	0	4	0	0	55	0	0	63	16 %
	Dry Bulk	3	0	10	6	0	26	0	0	45	12 %
	Vehicles	0	0	0	0	0	0	11	0	11	3 %
	Total	29	7	14	18	38	139	79	59	383	100 %
	Percent	8 %	2 %	4 %	5 %	10 %	36 %	21 %	15 %	100 %	

SITC 0: Food and Live animals
SITC 1: Beverages and tobacco
SITC 2: Crude materials, inedible, except fuels
SITC 3: Mineral fuels, lubricants and related materials
SITC 4: Animal and vegetable oils, fats and waxes
SITC 5: Chemicals and related products
SITC 6: Manufactures goods classified chiefly by material
SITC 7: Machinery and transport equipment
SITC 8: Miscellaneous manufactured articles
SITC 9: Commodities and transactions not classified elsewhere in the SITC

Of the “Food and live animals” (0), the foodstuff is mainly transported by truck, sorting under General Cargo, with exception for a few rail transports of foodstuff in the Dry Bulk form. Sugar/sugar preparations, fruit/vegetables and dairy products are three important sub groups in the sample._The few observations of “Beverages and tobacco” (1) sort under General Cargo in the survey data and are mainly within the sub category of alcoholic beverages. “Chemicals and related products” (5) sort under General Cargo and are represented among both truck and rail shipments. Half of the chemical shipments are not further specified by the respondents. The others span from perfumery/soap to fertilizers. Plastics in different forms are important sub categories in this category. “Machinery and transport equipment” (7) is the third largest category according to number of shipments, but the volumes are small and almost solely shipped by truck. The transport equipment sorts under Vehicle and other types of machinery under General Cargo. Electronic equipment and household electronics as well as industrial machinery and transport equipment are represented. “Miscellaneous manufactured articles" (8) contains all kinds of finished products, mostly typical consumer goods, not represented within the other SITC groups. These products are all classified as General Cargo, and different types are often transported collectively within the same shipment.

"Manufactured goods as classified chiefly by material" (6) are manufactured products that can be defined by type of material, i.e. only one material type is represented (wood, iron, rubber etc.) Metal, construction materials, wood and paper are the most important materials. Products within this group can often be referred to as semi-finished, as they are used as input factors to more composite articles. The observations of SITC category 6 in the survey are spread between the three cargo types General Cargo, Semi-Bulk and Dry Bulk in the modApp classification. As Semi-Bulk and Dry Bulk are not significant in the segment where intermodal transport is utilised, this confirms that the kind of semi-finished goods are less prone to be transported by intermodal transport solutions. This finding also confirm that the WP6.1 sample is consistent and representative with professional knowledge that general cargo (i.e., primarily consumables) dominate the market for intermodal services.

APPENDIX C: ETIS-BASE

ETIS (European Transport Policy Information System) Base for year 2000 and projection year 2020 (http://www.iccr-international.org/etis/) is an information system of integrated policy tools to support policy analysis and policy making. It includes a data element also referred to in terms of the "ETIS-Base". ETIS is based on an update of flows derived as part of the TEN-STAC project (Scenarios, Traffic, forecasts and analyses of Corridors on the Trans-European, http://www.nea.nl/ten-stac/).

ETIS-Base contains seven groups of data, where one of them is the "freight transport demand data set". As part of the freight demand data a "mother matrix" for freight P/C transport chains is provided. The "mother matrix" includes more than five million records. Each record describes a flow in terms of several variables: *year, production region, first transhipment region, second transhipment region, consumption site, flow-type (domestic, intra-EU and extra EU), mode at origin, mode between transhipments, mode at destination, NSTR 1 (+ crude oil separate) commodity classification, Hazard (0/1), chilled (0/1), manifestation of the goods, value (only for international flows) and tonnes of the flow, Volume in TEU*[33]*, distance between production and consumption regions*. There are a total of 293 regions. The zoning system covers the whole world, but with a much greater detail in some European countries (NUTS2). The "methods-template.xls" document says: "Note that only the data in relation with the core area (EU-25 + Norway + Switzerland) can be considered complete. Countries outside this core area have only been included in relation with the core area. Cells with no values for relations entirely outside the core area mean that no data are included. Cells with no value for relations with at least one side in the core area mean that the value of the flow is zero."

The modes represented in ETIS-Base are: *road, rail, inland waterway, sea, other* and *unknown*. Many combinations are possible as there are three lags per PC record. Manifest group[34] can be "general cargo", "liquid bulk", "semi bulk", "dry bulk", "vehicles" and "crude oil". In order to reduce the number of mode-chains, we use an aggregation to three modes, namely: truck-only, rail-based and other-modes. The spread sheet with documentation of ETIS data ("method template.xls", sheet 3.2) says "At the 5 digit SITC

[33] In sheet 3.5 of "method templates.xls" "words of caution" says: "Note that tonkm, TEUkm and vehiclekm are only determined for O/D relations (so following the vehicles from origin to destination) and not for P/C relations (following the commodities from production to consumption)".

Unfortunately the variables for "unitised goods in tonnes" and "volume in TEU" are always "-1". It is confirmed by NEA (pers.comm Fred van der Wouden, DEMIS) that the variable for unitised tonnes was never established in ETIS-Base. At the 5 digit SITC commodity classification level it is determined whether the goods are temperature controlled or ambient, whether they are hazardous and what is their manifestation (see 3.1 I ETIS doc "method templates.doc).

TEU is defined as Volume of unitised goods in number of TEUs and "unitised tonnes" is defined as Volume of unitised goods in tonnes.

[34] According to personal comunication with S.Newton (NEA), The MANIFEST commodity type classification of the ETIS data was to provide a simple classification of the commodities, similar to the definitions commonly used to report port statistics, also called mode of appearance. Most manufactures are contained in code 31 (general cargo), 32 liquid bulk is typically petroleum and chemicals, 33 semi –bulk tends to be forest products and some forms of steel, 34 dry bulk includes grain, aggregates, coal etc, vehicles, 35 is mainly new cars, and 36 is crude oil. With this kind of classification you can summarise the activities of a port quite well.

commodity classification level it is determined whether the goods are temperature controlled or ambient, whether they are hazardous and what their manifestation is". WP6.1 data and other relevant data sources are classified according to SITC. Thus, it would be beneficial if the conversion table NEA used for the classification of manifest group - based on SITC groups.

The truck-only mode represents all transport chains where truck is the only mode of transportation. This may include ferry transport, however, as ferry is usually considered an elongation of the road[35]. The rail-based mode includes all transport chains where rail is utilised either uni-modally or in combination with any other mode. Other transport includes those transport chains that aren't represented in terms or truck-only and rail-based transport (e.g., truck in combination with transport by inland waterways, seaborne transport other than ferry and other transport solutions).

Transhipment information can to some extent be used to identify the route of the flows (i.e., which corridor is currently utilised for intermodal transport).

Weaknesses of ETIS-Base are mentioned under "word of caution" in the documentation-file that comes with the data base, i.e., "method_templates.xls". For example we find in ETIS-Base that domestic freight flows of the Nordic countries (Norway, Sweden and Finland) are dominated by truck transport (more than 90% in tonnes). This isn't correct in the case of Norway, where as much as 50% of the total freight tonnes are carried by boat along the Norwegian coast. It is uncomfortable to detect these types of errors, but for the REORIENT study domestic transport is not of primary concern, and it is believed that we can be more confident in how the international freight flows are represented in ETIS-Base.

C.1 Manipulating ETIS data

Our philosophy of exploiting the data was to start out by looking at the data at relatively aggregate zoning level and then disaggregate the flows while reducing the geographical scope of the flows to the flows that are of specific interest to the REORIENT project.

To extract the desired data from ETIS-Base, the complete ETIS-Base was first transferred and represented in a Microsoft Access data base. Then we used the Microsoft Excel facility that makes it possible to import external data and aggregate the imported data in terms of pivot tables. The pivot table facility in Excel made it possible for each manifest group to aggregate to total flows, truck-only and all flows with no rail involved. The rail based flows are obtained by subtracting flows with no rail involved from total flows. Then other flows were obtained by subtracting truck-only flows from flows with no rail involved. A program was developed in Mathematica that was used to read the pivot-tables from Excel and aggregate to suitable zoning.

[35] A brief supplementary look at the ETIS-Base revealed that there were no transhipments in Sweden with production site in Norway. We assume this is because freight from Norway through Sweden goes by truck and on ferry to further destinations on the continent and because ferry is considered as part of the road in available statistical sources. Although the text is a bit unclear, our interpretation of the description of data about freight and passenger mode split in the ETIS D5 main report (2004) "ETIS-Database methodology development and database user manual – synthesis report. V2.1" is that ferry transport is included as part of the road mode (which is reasonable as ferry is often considered as an elongation of the road).

We extracted values of variables of year 2000 *of production region, consumption region, and mode at origin, mode between transhipments, mode at destination, manifestation of the goods, volume (tonnes) and value (€1000) of the manifested goods.* We divided by 1000 to have values in 1000 tonnes and €1000 000.

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