Strategies for Increasing Intermodal Transport between Eastern and Western Europe

Final Report

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Note: The annexes to this report are available in a separate volume, which is not published in the “IVT Schriftenreihe”. Please contact the authors directly via www.ivt.baug.ethz.ch.
# Executive Summary

## 1 Introduction

### 1.1 Background

Rapid growth in trade caused by new economic development is expected to place increasing demands on transportation infrastructure and logistics management on east-west connections to and from Eastern Europe. This increased trade affects the ten European Union accession countries (2004) and all other eastern and central European countries.

Eastern Europe’s infrastructure is relatively undeveloped, and this has given rise to fears that trade growth will increase traffic congestion, logistic bottlenecks and environmental problems.

The Danzas Foundation for Logistics sponsored the Institute for Transport Planning and Systems (ETH Zürich) for analysing strategies for increasing intermodal transport on these connections to and from Eastern Europe.

The purpose of this research project was first, to identify the potential for increasing intermodal transport between Eastern and Western Europe by evaluating the current infrastructure network, legal framework, market conditions and cost structure, and, second, to identify possible business, market, and operating strategies needed to achieve that potential. These strategies can help all partners in the intermodal transport chain improve their operations and thereby operate successfully in this promising transport sector.

### 1.1.2 Methodology

The study methodology consisted of the following steps:

1. Evaluate market conditions, infrastructure, and legal conditions in central and Eastern European countries;
2. Identify the most promising transport relations between these countries and Western Europe (EU 15);
3. Prepare a detailed market and cost analysis for the most promising transport relations;
4. Identify potential business, market and operational strategies for sustainable development of intermodal transport on these relations.

## 1.2 Market Potential and Transport Costs

### 1.2.1 Market Analysis

An essential precondition for the successful implementation of intermodal services is to have sufficient potential transport volumes of goods suitable for intermodal transport in both directions (including triangular relations, loops etc) in order to avoid empty wagon movements.

The foreign trade statistics for European Union member states from Eurostat (the EU’s statistical office) were used to analyze the status quo intermodal freight transportation between Western and Eastern Europe along the most promising corridor.

The evaluation of market conditions, infrastructure, and legal conditions showed that, out of 6 possible corridors, the one called “Axis D” has the most potential for increasing intermodal transport in the future. Axis D is a pair of east-west axes linked to each other:

- Southern Germany – Czech Republic / Southern Poland – Slovakia – Ukraine, and
- Switzerland – Austria – Hungary – Romania – Bulgaria.
The following figures show the actual volume of cargo (year 2004) suitable for intermodal transport.

**Figure 1.1: Potential volume for intermodal transport (direction west-east)**

Source: Eurostat; Figure: IVT

**Figure 1.2: Potential volume for intermodal transport (direction east-west)**

Source: Eurostat; Figure: IVT
These transport volumes correspond to the actual transported freight tonnages for 2004, independent of transport modes. In estimating the market potential for intermodal transport, it is assumed that only a share of these goods could be moved by intermodal transport.

An important result is the balance of volumes transported from west to east and vice-versa. Apart from a few exceptions the volume difference between two countries in either direction does not exceed 25%. Therefore we state that in case of Axis D the preconditions are fulfilled.

The transport volumes presented in the figures above must be considered approximate for the following reasons:

- The selection of goods categories that can be moved by intermodal transport may differ. For this analysis we tried to make a realistic selection and, in case of doubt, did not include the goods category.
- The quality of the existing data varies with each individual EU member country, especially because they use slightly different methodologies for collecting data from surveyed companies.

The determination of the future freight volume for intermodal transport is linked to an assumption for the modal split of the intra-European freight traffic and depends on economic growth in Europe.

**1.2.2 Cost Analysis**

**1.2.2.1 Scenario Overview**

The research analysed how transport costs are likely to develop in the coming years assuming an expected rise in fuel prices and wage costs in Eastern Europe consistent with the appropriate EU legal framework.

The existing low cost level in the road transport sector in central and Eastern Europe does not allow offering profitable intermodal transport services (except certain long distance services and seaport hinterland transport). A sensitivity analysis was performed to test the impact of changes to three selected variables (fuel prices, wage costs, and road tolls) on the competitiveness of intermodal transport. Two scenarios were tested: a “Trend Scenario” and a “Maximum Scenario”. Table 1.1 gives an overview over the most important cost elements and their expected future development:

<table>
<thead>
<tr>
<th>Cost element</th>
<th>Prognosis “Trend Scenario”</th>
<th>“Maximum Scenario”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolling Stock (annuity,</td>
<td>(no change)</td>
<td>(no change)</td>
</tr>
<tr>
<td>maintenance, insurance)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>+50% in road transport;</td>
<td>+100% in road transport;</td>
</tr>
<tr>
<td></td>
<td>+25% in intermodal transport</td>
<td>+50% in intermodal transport</td>
</tr>
<tr>
<td>Infrastructure Charges</td>
<td>0.125 €/km (EU-wide standard)</td>
<td>0.15 €/km (EU-wide standard)</td>
</tr>
<tr>
<td>Wage Costs</td>
<td>+50% in road transport</td>
<td>+100% in road transport</td>
</tr>
<tr>
<td>Terminal Handling</td>
<td>(no change)</td>
<td>(no change)</td>
</tr>
</tbody>
</table>

The determination of the future freight volume for intermodal transport is linked to an assumption for the modal split of the intra-European freight traffic and depends on economic growth in Europe.

**Table 1.1: Important Cost Elements and their expected Development**
The cost analysis only considered operational costs. It assumed that the necessary investments in the infrastructure and the transport boxes (containers) had already been made. Furthermore, since the infrastructure for both road and intermodal transport should be at least partly provided by the government, only the amortisation costs for rolling stock were included in the analysis. Thus, the analysis considers only specific costs depending on time, distance and transport units.

1.2.2.2 Results

Figure 3 compares the cost per twenty-foot equivalent unit (TEU) for road transport (truck full load) with intermodal transport (continuous main haulage between two large terminals with 50 km pre- and post-haulage distance).

Figure 1.3: Break-even Analysis – Status Quo (cost level 2005)

Figure 4 illustrates the impact of pre and post haulage on intermodal transport costs. It includes the same curves from Figure 3, but adds dashed lines to show the cost curves for the 20 km (green) and 70 km (brown) pre-and post-haulage distance.

Source: IVT
Figure 1.4: Influence of Pre and Post Haulage Distance

Source: IVT

Figure 4 clearly illustrates the importance of an optimised terminal location. Reducing the average distance between intermodal terminal and the customer by 30 km reduces the break-even point between road-only and intermodal transport by 293 km (or 21%) to approximately 1100 km. Taking 70 km as the reference distance, the difference to the 20 km distance is 466 km (or 30%).

Figure 5 presents results of the cost analysis for the Trend and Maximum scenarios.

Figure 1.5: Prognosis with Pre and Post Haulage Distance 50 km

Source: IVT
As shown in Figure 5, the two scenarios show a significant decrease of the break-even distance. The break-even distance shifts from 1380 km in the status quo scenario to 898 km in the trend scenario (a reduction of 35%), and to 640 km under the maximum scenario (a reduction of 54%).

1.2.2.3 Cost Analysis Conclusion

The cost analysis results show that within the next 10 – 15 years intermodal transport has a good chance of becoming competitive on medium distance routes of 500 – 700 km. This means that on routes with high demand (e.g. Southern Germany – Slovakia/Western Hungary which has significant trade in the automotive sector) intermodal transport may be expected to show significant gains in market share.

However, an important caveat is that the intermodal transport must also cope with the customers’ quality requirements to be a competitive alternative. Cost is not the most important aspect for the choice of a suitable transport mode.

1.3 Recommended Strategies

1.3.1 Major Problems in Intermodal Transport

From the customer’s viewpoint today intermodal transport is non-competitive with road transport on many potential relations.

- Intermodal transport is more expensive than road transport;
- Intermodal transport takes longer than road transport;
- Intermodal transport is less reliable than road transport;
- Intermodal transport’s service offer (routes, frequency) is insufficient to meet the customers’ needs.

Therefore we have to distinguish between two main aspects:

- Quality (i.e. reliability and speed);
- Coverage area (i.e. number of service routes offered).

1.3.1.1 Quality

The greater the number of independent partners involved in the intermodal transport chain, the more complex the intermodal transport becomes. This is because the management of information between different partners is a huge problem. In contrast, if a single partner operates several elements of the transport chain, there are fewer external interfaces, and the management of information flows becomes more efficient. Another problem in transport chains with many independent partners are the unclear responsibilities towards customers and between the partners.

The following strategies are recommended to solve (or at least reduce) these problems:

- Reduce the number of independent partners in the transport chain;
- Create a clear hierarchical organization of the transport chain;
- Develop a uniform information interface.

In addition to the problems caused by many partners, there are also problems in the production processes (i.e. main haulage, pre and post haulage etc.). Two problems associated with the main haulage not exclusively under the control of operators are insufficient infrastructure capacity and the priority given to passenger trains on rail networks. These problems can only be solved with rail freight infrastructure investments (capacity upgrades).
and policy changes. There are several problems with the pre and post haulage process. In most cases this process is inefficient and cost intensive due to poor use of capacity, organizational problems, and long pre- and post-haul distances. Improving the efficiency of the pre- and post-haulage process can help to reduce cost and quality problems for the entire intermodal transport chain.

1.3.1.2 Network Building

In many cases a customer’s needs cannot be satisfied with the existing intermodal transport offer since it consists of only a fairly small number of existing intermodal transport routes. This problem must be addressed by creating new and/or denser intermodal networks.

The first step in building a network consists of connecting terminals that are operated by a single terminal operator. The second step, building up larger networks between different terminal operators, requires different operators to cooperate by handling shipments from other operators.

Terminals are the key part of the intermodal freight transport network. Since they perform the same interface function between transport modes as passenger railway stations, we see that terminals must be part of the public infrastructure and thus should, at least partly, be financed by public means of investment (or public-private partnership). The guarantee of free access to terminals is a basic condition for network building. It is a task for EU (and national) legislation to create an appropriate legal framework.

With these preconditions we can also ask for international (public) coordination in terminal planning. A macroeconomic point of view is necessary to determine the optimal location for a terminal in terms of demand and efficiency. Therefore international (public) organisations should be given the responsibility to determine or control the locations for new intermodal terminals.

1.3.1.3 Cooperation

In order to create competitive intermodal networks on an international scale, cooperation between several intermodal providers (and other partners involved in the transport chain) is essential. The basic preconditions for successful cooperation of two or more independent companies are:

- Similar business objectives;
- Reliability of partners;
- Medium/long term prospect for success.

The problem of unreliable partners has to be overcome by contract penalties. Contract penalties can be an effective way of assuring contracting partners’ reliability and quality, if responsibilities are clearly defined throughout the transport chain.

In most cases reliable prospects for long-term profit are unrealistic due to uncertain demand forecasts. Since intermodal transport requires large investments (e.g. in terminal infrastructure and rolling stock), high financial risks arise for the partners. A possible solution is sharing the investment risks between several partners and public authorities.

1.3.2 Business Strategies

Based on the problem analysis a number of business strategies for each partner of the intermodal transport chain could be derived.

1.3.2.1 Status Quo

Today the organisation of the transport chain is not geared to the actual transportation process, as illustrated in the following figure. This organisational structure implies that the
terminal processes would have to be aligned with the pre- and post-haulage (PPH) process, because the intermodal provider operating the terminal is a subcontractor of the forwarder who manages the PPH. The problem with this organizational structure is that more than one operator does the PPH for the terminal, and these PPH processes must be coordinated with the terminal processes. If the terminal operator has no influence on the PPH, then he has no ability to optimise his internal processes.

Figure 1.6: Multi-partner Operation model – Status Quo

Source: IVT

1.3.2.2 Recommended Strategies

Given the cost, coordination, and quality problems with the existing intermodal transport system, the optimal strategy would be for a single company to manage the whole process and to provide door-to-door freight transport service. Today, especially on international routes, this strategy is often hard to realise.

Alternatively, the most realistic strategy to pursue is to minimise the impact of interfaces in the transport chain. This strategy consists of:

- Better coordinating the operation of terminals with pre- and post-haulage, and
- Having intermodal providers manage the main haulage connections between terminals.

Figure 7 illustrates the proposed operation model with an intermodal provider being in charge of the terminal operation with direct control of the pre- and post-haulage and main haulage processes. The forwarder’s role is to establish the connection to the consignor and to choose for the latter the suitable (intermodal) transport provider. If the demanded connection exceeds the network of one provider, in some cases (if there is no direct cooperation) the forwarder has to coordinate several providers to forward the shipment from one to another.
Several variations of this strategy are possible: for example a main haulage operator (railway company) can take on the role of an intermodal operator.

### 1.3.3 Market Strategy

Based on the corridor considered in this analysis (Axis D), generally speaking the best strategy is a combination of axis and area-wide oriented transport offers. The low market share for intermodal transport on short and medium distances means that only a few relations will have freight volumes high enough to justify regular direct train links within the EU.

As a consequence, it is necessary to combine different commodity flows efficiently on the main haulage network. The recommendation is to combine goods flows from several less important relationships on to a core network, which is designed based on the high potential transport relations. The principal nodes on this network can be used as the base points to create several regional networks designed to provide service to areas of medium and low demand.

In cases where a single operator is not capable of operating a proper network by itself and prefers to focus on a single axis strategy, it is essential for the operator to cooperate with other operators to link several axes and regions into an integrated network.

### 1.3.4 Operational Strategy

The proposed strategy for the main haulage process in intermodal transport can be displayed as an integrated model – a hierarchical system divided in three levels of service as illustrated in Figure 8.
The first and second level represents the proposed intermodal network comprising a principal (or core) network and several regional networks. Level 3 represents the option of integrating intermodal transport in existing networks for wagonload transport.

**Level 1** covers the principal network on a multinational scale. High potential axes running in orthogonal direction provide the interconnections necessary for a proper network structure. The connecting points represent the central intermodal hubs between which regular direct trains guarantee a constant high level of service and quality. These direct trains may either be shuttle trains or block trains.

**Level 2** represents a number of regional networks structured around the central hubs of the principal network. Those networks serve to achieve a higher coverage of the market in order to operate the core network at higher capacity.

**Level 3** is an appropriate additional solution for all transport flows that cannot be handled with dedicated intermodal services and for private sidings. The quality is lower than on the first two levels, because transport times are longer and operational costs are higher.

Source: IVT
2 Introduction

2.1 Background

Rapid growth in trade caused by new economic development is expected to place increasing demand on transportation infrastructure and logistics management in Eastern Europe. This increased trade affects not only the ten European Union accession countries (2004) but also all of eastern and central Europe (including Romania, Bulgaria, the Balkans and members of the Russian Federation).

Eastern Europe’s infrastructure is relatively undeveloped and this has given rise to fears that trade growth will increase traffic congestion, logistic bottlenecks and environmental problems.

The purpose of this report is to identify business, market and operational strategies for increasing intermodal transport between eastern and western Europe by evaluating the current infrastructure network, legal framework as well as cost and market conditions. The study was sponsored by the Danzas Foundation for Logistics.

2.2 Trans European Transportation Network

The purpose of the European Union is to build a mutual market and homogenous social setting for member nations. In order to achieve these aims, the EU needs efficient networks for energy supply, telecommunications and transportation. Therefore, the EU’s Maastricht Treaty (1995) calls for development of a Trans-European transportation network (TEN).

The TEN network is designed to link the major cities and economic areas throughout Europe (both inside and outside the EU). The network is illustrated in Figure 2.1. It consists of ten corridors each containing several different transport modes (e.g. road, rail and waterway). The idea is to concentrate international traffic in these corridors.

As part of the EU’s development strategy, a large number of specific infrastructure improvement projects have been identified for the TEN corridors. These high profile projects are intended to better coordinate national and international network development and to improve trans-border transportation. The corridors include improvements to infrastructure of central, eastern and south-eastern European countries. Progress on implementing the TEN corridors and infrastructure projects differ significantly between regions and countries.

2.3 Intermodal Transport

Intermodal freight transport (or combined transport) means movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes. This research study focuses on road-rail transport, i.e. the principal transport process (main haulage) is done by rail, while the comparatively short connection between terminal and consignor or consignee is normally established by road transport.

There are two main types of intermodal transport:

- Accompanied combined transport means transport of a complete road vehicle, accompanied by the driver, using another mode of transport (for example ferry or train).
- Unaccompanied combined transport means transport of a road vehicle or an intermodal transport unit (ITU), not accompanied by the driver, using another mode of transport (for example a ferry or a train).
The first type is generally used when the distance transported by train or ferry is relatively short, while the second is used when this distance is longer.

**Figure 2.1: Trans European Transportation Network (TEN) Corridors**

### 2.4 Study Methodology

The research study consisted of three main parts outlined below.

The first task consisted of collecting data and evaluating market conditions, infrastructure and legal systems from each of the countries analyzed, namely

- Russia,
- Belarus,
- Poland,
- Czech Republic,
- Slovakia,
- Hungary,
- Romania,
- Bulgaria,
- Ukraine,
- Slovenia,
- Croatia,
- Balkan States (Serbia/Montenegro, Bosnia/Herzegovina, Macedonia, and Albania), and,
- Baltic States (Lithuania, Estonia and Latvia).

This information was used to help define economic areas.

The second task consisted of eliminating transport corridors, economic regions and markets in an effort to identify the best markets for intermodal transport. Transport corridors were eliminated if they had problems or limits imposed by geography or logistics. Markets and economic areas were eliminated if market conditions and legal structures could not expected to permit significant growth in the future.
The third task consisted of preparing an overview of the remaining markets/areas covering potential volume, infrastructure and legal structure and developing specific proposals for the transport corridors. The most promising corridor was then analysed in detail on potential volumes and transport costs.

Finally, based on the assembled data, general problems in intermodal transport were identified, and business, market and operational strategies were proposed to overcome these problems.
3 Evaluation of Market, Infrastructure and Legal Structure

3.1 Methodology

The evaluation of markets, infrastructure and legal structure consisted of an analysis of these factors for each of the countries considered in the research. Economic areas were also determined using these data.

These data were used to eliminate unpromising areas and markets with little expected economic growth. The evaluation was completed by ranking market conditions, infrastructure and legal structure using the following three point schemes:

- **Market Analysis:**
  - III: strong potential demand (import or export) for transportation of goods suitable for intermodal transport;
  - II: high general demand today; promising future demand for intermodal transport;
  - I: no current demand, future demand uncertain.

- **Infrastructure and Legal System Analysis:**
  - III: approximately EU-standard; few capacity bottlenecks;
  - II: lower than EU-standard but satisfactory, development and expansion possible.
  - I: lower than EU-standard but satisfactory, development and expansion uncertain.

The evaluation measures presented in Table 3.1 were used to determine which countries would be evaluated in detail as part of this research project. A country that received a “I” in any of the three categories was excluded from further analysis.

3.2 Data Analysis

3.2.1 Data Sources

One of the problems faced in this research was the lack of high quality transportation data currently available for the countries in Eastern Europe. Therefore data from the following sources was used to help prepare the report:

- Literature (Statistics, Internet, International Magazines and Publications, Daily Press, etc.)
- Information from DHL country organisations provided by questionnaires
- External Experts (TU Dresden, Incertans Bukarest, Prometni Institut Ljubljana)

An especially important part of the analysis was the participation of partners from Eastern Europe. They helped obtain missing data and reviewed the analysis thus providing a second opinion on the research conclusions and methodology.

The data used to evaluate the countries/regions considered in this research are presented in Appendices 1 (market conditions), 2 (infrastructure) and 3 (legal framework). The market conditions data includes basic economic data such as gross domestic product, a list of economic sectors, average wages, information on market trends, and major exports/imports. The infrastructure data includes qualitative and quantitative information on the country’s rail network, road network and waterway network. The legal framework data includes tax rates, customs information and an assessment of legal/tax issues in each country.
### Strategies for Increasing Intermodal Transport between Eastern and Western Europe

#### Table 3.1: Evaluation Factors

<table>
<thead>
<tr>
<th>Settings</th>
<th>Indicator</th>
<th>Measurement Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Market</strong></td>
<td>Economic Sector</td>
<td>Agriculture, industry, services: GDP(^1), Employee’s contribution (%)</td>
</tr>
<tr>
<td></td>
<td>Industrial sectors</td>
<td>Resource orientated vs. product orientated: approximate contribution</td>
</tr>
<tr>
<td></td>
<td>Foreign Trade</td>
<td>Major import/export goods</td>
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<tr>
<td></td>
<td>Economic Growth</td>
<td>GDP/ GNP(^2) per inhabitant in purchasing-power parity</td>
</tr>
<tr>
<td></td>
<td>Gross Wage</td>
<td>Average gross wage in purchasing-power parity</td>
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<tr>
<td><strong>Infrastructure</strong></td>
<td>Rail Network Quality and Capacity</td>
<td>Available train paths, network density, number of engines</td>
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<tr>
<td></td>
<td>Interoperability</td>
<td>Axle load, track gauge, electrical power system, vehicle clearance profile etc.</td>
</tr>
<tr>
<td></td>
<td>Intermodal Terminal Infrastructure</td>
<td>Number of terminals, locations</td>
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<tr>
<td></td>
<td>Quality of Road Network</td>
<td>Network density, capacity, maintenance level, possible capacity bottlenecks</td>
</tr>
<tr>
<td></td>
<td>Topography</td>
<td></td>
</tr>
<tr>
<td><strong>Legal Structure</strong></td>
<td>Fiscal System, Customs Regulations, Economic Policy, General Settings</td>
<td>Impact on Intermodal Transportation</td>
</tr>
</tbody>
</table>

3.2.2 Country Analysis

3.2.2.1 **Russia**

Russia presents a difficult political and economic environment. Since the break-up of the Soviet Union, the country has struggled with corruption and supplying its population with sufficient food and goods. Russia possesses considerable development potential for imports and exports based on its size and upon the country’s vast natural resources.

Russia’s main transportation system is the railroad. The Trans-Siberian Railroad is of special importance, because it connects Europe and Asia. Its importance is growing for transit goods traffic (full intermodal trains). Furthermore, the railroad’s route passes through mineral-rich regions. For both these reasons the Trans-Siberian Railroad occupies a special position in the European transport market. The transit freight traffic via Latvia to Kaliningrad was impaired recently (September 2004) by the Baltic States after their accession to the European Union. Costs increases in the customs, the reduction of railroad checkpoints as well as problems with animal and food controls interfere with goods import and export.

3.2.2.2 **Belarus**

The economic situation in Belarus can be characterized as difficult. The country has not made much progress in economic reforms including privatization of nationalized industry. The

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\(^1\) Gross Domestic Product

\(^2\) Gross National Product
government is holding on to a centralized command economy as well as imposing heavy regulations on the economy, and imposing price controls for staple goods. Finally, there is a lack of safety, legal process and political stability. However, the infrastructure is intact and can manage the east-west and north-south transit flows. The country’s complicated tax system and difficulties with customs authorities make it difficult for foreign investors.

### 3.2.2.3 Poland

Poland is an important transit country for the east-west and north-south traffic; three of the Pan-European corridors pass through Poland. Most western European countries consider Poland to be the gateway to the East. The existing infrastructure is insufficient, however significant investments will be made to it during the coming decade (especially the road network).

Poland’s main economic advantage are its low ancillary wage costs compared to western European countries and its large number of well-trained workers (especially in technical disciplines). However, high additional wage costs and the social insurance contributions are a problem. Poland’s economic growth remains static and unemployment is growing, recently. Duty free zones are in place at Poland’s Baltic Sea harbours (Gdansk, Swinoujscie, Szczecin and Mszechkonow). Technology parks and centres are located in Gdansk, Krakow, Lodz, Poznan, Warszawa and Wroclaw.

### 3.2.2.4 Czech Republic

The advantages of the Czech Republic are an intact infrastructure, a large number of skilled (linguistically and technically) workers and the reward level (500 €). Good market chances exist for providers of environmental technology. A disadvantage is the obstruction to economic reforms including: corruption, insufficient creditor protection as well as low efficiency and transparency of government and justice.

In terms of infrastructure, the Czech Republic can be characterised as having a dense national railroad network and a good road quality. Duty-free zones exist in cities including Cheb, Hradec Králové, Ostrava, Prague and Zlín. There are also numerous industry zones for example in Chrudim, Lovosice, Moravská Trebová, Nosovice, Pardubice and Svitavy. Additional zones are under construction.

### 3.2.2.5 Slovakia

In the Slovak Republic, the vehicle industry is known as the motor of economy and export. It is expected that the business volume of automobile component supply companies will increase faster than the one of automotive manufacturers. Slovakia’s uniform tax rate, comparatively low wage costs (317 Euros/year) and a large number of relatively highly skilled workers make it an attractive business location. Well-educated and highly motivated employees are found especially in the IT-sector. Bratislava offers surpassing well-trained employees.

The country’s geographic situation, in the heart of the expanded EU, represents a location factor of special importance. However, in spite of its many advantages, many investors are deterred by the country’s poor infrastructure compared to Western Europe. Numerous industry parks are under construction.

### 3.2.2.6 Hungary

Hungary’s economic stability and the development of new markets as well as the high education level of its workers are of importance for investors. The specialists are well trained, especially engineers, technicians and employees of the IT-sector. On the other hand, Hungary can no longer be classified as a low wage country and the country’s low productivity level is also a problem. The 2001 wage level increase was higher than productivity gains that
brought into question international competitiveness of most companies. Another problem are the bureaucracy in relations with the government and corruption.

The preferred business locations in Hungary are Budapest (and surrounding area) and the Győr/Sopron area near the Austrian border. These locations will soon be connected to 13 logistics parks. The transportation infrastructure is excellent compared to other Eastern Europe countries, however large investments are still necessary to bring it up to EU standards.

3.2.2.7 Rumania

The advantage of Rumania is that it is a candidate country for EU membership. The ancillary wage costs are low and specialists are well trained. This is especially true for technical and IT-business (hardware and software) where the workers are well trained and highly motivated. A high market potential for western investment and consumption goods exists, but the population possesses a very low purchasing power. The country also has problems with its legal system (uncertainty), corruption and government nepotism.

Rumania’s infrastructure is partly deficient. The country has traditionally had a distinct share of the international Danube ship traffic. The large harbour of Constanta plays an important role in freight transport to Germany on the Danube and reverse to Black Sea countries. Currently several industry and technology parks are under construction (for example in: Bacau, Bracow, Cluj, Galati, Sibiu and Timisoara). Duty-free zones exist in Arad/Curtici, Braila, Constanta, Galati, Giurgi and Sulina.

3.2.2.8 Bulgaria

Bulgaria is also an EU candidate country. Its advantage is its geographic situation, centred on the Balkan Peninsula and therefore it represents a gateway between east and west. Furthermore the country’s wage level is low and its political and economic systems are stable, although corruption remains a key problem. The country’s main disadvantages are its poor industrial basis and the dramatic social situation of many citizens.

3.2.2.9 Ukraine

Ukraine is currently experiencing very high economic growth rates, but the country will not be able to sustain this growth without making structural changes to its economy. Ukraine’s competitive advantage is based on the re-starting of obsolete industry complexes, low wages, the lack of a social security system and the neglect of all external production costs. These factors are not conducive to long-term growth. The country needs structural reforms, the improvement of institutional background and a solution for distribution problems.

Ukraine’s transportation infrastructure is intact but archaic. The Ukraine is marked through domestic turmoil, unsteady legal settings, a doubtful democracy and questionable credit worthiness. Future governmental decisions will be decisive for its further development, whether Ukraine will continue its approach towards the EU.

3.2.2.10 Slovenia

Slovenia’s economy performs better especially in growth dynamics and the per-capita income is higher than in any of the other southeastern European countries. The economic policy and the national agencies perform best in comparison to all the other 2004 accession EU-countries.

The country’s foreign trade is evolving. Germany is the most important trade partner followed by Italy, Croatia and Austria. Main sectors for imports and exports are automobiles, engineering, consumption and chemical products. The economy changed to a free-enterprise system. Slovenia is known as a reliable trade partner and fights consistently corruption, which is an important competition factor for the Eastern European trade market. Slovenia is a stable country.
The geographic vicinity to important EU countries (Germany, Austria and Italy) is an advantage, too. It is certain that trade firms will expand to Slovenia and use the country as a bridgehead to Croatia and Serbia. The transportation infrastructure is in good shape based on western standards.

3.2.2.11 Croatia

Croatia developed very quickly after the government turnover and cannot be characterised as a typical Balkan state. The country’s industrial base is developing. The Croatian harbours do not presently play a large role although they do have potential in the future.

3.2.2.12 Balkan Peninsula

The countries on the Balkan Peninsula (Ex-Yugoslavia, Bosnia and Herzegovina, Macedonia, Albania without Slovenia and Croatia) are not likely to become EU members in the near future since they are still being affected by the political turmoil, riots and social commotion of the 1990s.

Albania is uninteresting based on its geographic situation, economic weakness and small size.

3.2.2.13 Baltic States

The Baltic countries (Lithuania, Latvia and Estonia) offer interesting starting points for strategic alignments of markets and businesses due to their geography and the trick disk function of these countries between “East and West.” Additionally, the Baltic States are growing economically. All three countries are developing industry in information technology and telecommunication. This is influenced by the vicinity to Nordic companies (worldwide leaders in telecommunications). Many of these companies look upon the Baltic States as a good place for outsourcing.

3.2.3 Development Potential of the Loading Industry

This section outlines the future intermodal freight strategies of important industrial sectors.

3.2.3.1 Automotive Industry

In view of the relatively low automobile ownership rates in the new EU countries, these countries have a high potential for development and economic growth. Based on population, Poland represents an especially attractive market. With increasing income, a gradual postponement of the demands to higher classes by debit small vehicles. But this process will take place slowly. Building vehicles in these countries is especially attractive, because plants can supply EU states as well as other Eastern countries.

3.2.3.2 Engineering

Currently companies are forced to make expensive investments in machinery to achieve EU standards and improve competitiveness. Based on its size and the rural structure Poland is likely to be the best market for engineering goods.

3.2.3.3 Electrical Technology

The fast development of domestic markets in some countries resulted in saturation for some consumer electronics such as televisions and CD players. But various sectors still have high potential including white goods (dishwashers, dryers, etc.), personal computers and other electronics. In view of increasing gross wages an expansion of manufacturing at least in very work-intensive sectors – e.g. assembly operation – but also electronics is questionable. Many of the new EU states have a disadvantage compared to other eastern countries as Bulgaria, Rumania and Russia or to Southeast Asia in terms of wages.
3.2.3.4 Chemical Industry

The chemical industry is highly capital intensive and therefore profits less from low wage levels than other industries. Instead access to raw materials, capacity, technical level of facilities and integration of production processes play an essential role for the competitiveness. The attraction of the new EU-countries to the chemical industry is based only partly on its labour supply characteristics, but rather in the development of local markets and raw material supply.

3.2.3.5 Agriculture and Food Products

The agriculture and food products sector is still in an adaptation process. As a consequence thereof large investments are needed more than ever to realize modernization. On the other hand East European countries compete strongly with the western countries with much higher food costs.

3.2.4 Market and Area Ranking

Each of the countries was evaluated using the methodology described above (see chapter 3.2.1) and the data collected during this research project. Table 3.2 summarizes the results of this evaluation.

<table>
<thead>
<tr>
<th>Country</th>
<th>Market Conditions</th>
<th>Infrastructure</th>
<th>Legal Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Belarus</td>
<td>I</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Poland</td>
<td>III</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>II</td>
<td>III</td>
<td>III</td>
</tr>
<tr>
<td>Slovakia</td>
<td>II</td>
<td>III</td>
<td>II</td>
</tr>
<tr>
<td>Hungary</td>
<td>II</td>
<td>III</td>
<td>II</td>
</tr>
<tr>
<td>Rumania</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Ukraine</td>
<td>I</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Slovenia</td>
<td>III</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>Croatia</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Balkan States</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albania</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td>Serbia and Montenegro</td>
<td></td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td>Macedonia</td>
<td>I</td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td></td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td>Baltic States:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Lithuania</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>Latvia</td>
<td>II</td>
<td>II</td>
<td>II</td>
</tr>
</tbody>
</table>

Legend: III – strong, II – satisfactory, I – weak

Table 3.2: Market and Area Ranking (Source: IVT)
3.3 Identification of East-West Transportation Axes

The next step in the research was to identify the main east-west transportation axes using results of the market data. These axes were determined by linking the key regions of the market in Western Europe (Scandinavia, north German ports, Berlin, Holland/Belgium ports, Ruhr area, Iberian peninsula including Mediterranean ports, Apennines peninsula, London, Paris and Lyon) to key regions in the east (Katowice, Warsaw, St. Petersburg, Moscow, Bratislava, Prague, Kiev, Bucharest, Varna, Sofia, and Odessa). As a special topic the axis from Moscow to Eastern Asia was also considered. In this research project the axes were named A, B, C etc., in order to differ from TEN corridors (which are designated by numbers). Figure 3.1 illustrates the transportation axes derived from the market analysis in the Eastern European countries.

![East-West Transportation Axes](image)

*Figure 3.1: East-West Transportation Axes (Source: IVT)*

3.4 Designation of Regions

As part of the research project individual regions were identified in Western Europe (Table 3.3) and Eastern Europe (Table 3.4) in order to evaluate in detail the future market potential for intermodal transport. The regions in Western Europe are of a larger scale than the ones in Eastern Europe.

Both tables list the main freight flows and identify the areas in terms of their consumer market. A consumer market listed as “consumer area” is a regional population with medium consumption possibility or an area with good consumption possibilities but less than 5 million inhabitants.
A consumer market listed as an “important consumer area” is defined as having good consumption possibilities and more than 5 million inhabitants (Slovakia) or medium consumption possibilities but more than 10 million inhabitants (Russian regions).

The market in the major regions is very multifaceted and, with respect to east–west transport flows, they are focussed mainly on consumer products coming from the east.

Note that Table 3.4 includes all the major Eastern European regions; regions with a bad score in Table 3.2 are listed but without special notes.

<table>
<thead>
<tr>
<th>Region</th>
<th>Freight Transport Source and Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scandinavia (Sweden, Norway, Finland)</td>
<td>Steel, Timber, Oil, Fish, machines; small consumer area</td>
</tr>
<tr>
<td>Northern Germany and ports (including Denmark)</td>
<td>Cars, various consumer goods industries, transit goods from seaports; consumer area</td>
</tr>
<tr>
<td>Berlin Area (and mid Germany)</td>
<td>Various consumer goods industries; important consumer area</td>
</tr>
<tr>
<td>Benelux, Ruhr area</td>
<td>Machine and chemical industry, transit goods from seaports, agriculture, logistic centres; important consumer area because of dense population</td>
</tr>
<tr>
<td>UK and Ireland</td>
<td>Various consumer goods industries; important consumer area</td>
</tr>
<tr>
<td>Northern France and Paris</td>
<td>Machine and metal industry, chemical industry, cars, various consumer goods industries; important consumer area and logistic centres (especially Paris, the main hub for goods to and from France).</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Various consumer goods industries; consumer area</td>
</tr>
<tr>
<td>Austria</td>
<td>Machine and metal industry, various consumer goods industries; consumer area</td>
</tr>
<tr>
<td>South of France</td>
<td>Agriculture, consumer area, transit goods from seaports</td>
</tr>
<tr>
<td>Iberian Peninsula</td>
<td>Car industry, various consumer goods industries, agriculture</td>
</tr>
<tr>
<td>Northern Italy</td>
<td>Car industry, various consumer goods industries, chemical industry; important consumer area</td>
</tr>
<tr>
<td>Southern Italy</td>
<td>Agriculture; sea port of Gioia Tauro is an important intermodal hub with worldwide connections</td>
</tr>
</tbody>
</table>

*Table 3.3: Regions in Western Europe*
<table>
<thead>
<tr>
<th>Region</th>
<th>Freight Transport Source and Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia: St. Petersburg area</td>
<td>Various industry for consumer goods; important consumer area</td>
</tr>
<tr>
<td>Russia: Moscow area</td>
<td>Machine industry; important consumer area</td>
</tr>
<tr>
<td>Belarus</td>
<td>--</td>
</tr>
<tr>
<td>Poland: Silesia region</td>
<td>Steel and metal machine industry, cars, railway industry.</td>
</tr>
<tr>
<td>Poland: Warsaw area and outside main industrial regions</td>
<td>Car, electro, textile and machine industry, agriculture in rural areas; important consumer area</td>
</tr>
<tr>
<td>Poland: Katowice region</td>
<td>Steel and machine industry, various industry for consumer goods and subassembly</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Car, machine, textile and food industry; important consumer area</td>
</tr>
<tr>
<td>Slovakia and western Hungary</td>
<td>Car, machine, chemical and food industry; important consumer area</td>
</tr>
<tr>
<td>Rest of Hungary</td>
<td>Agriculture, various industry for consumer goods; consumer area</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Car, machine, electro chemical, and various consumer good industry, transit goods from seaports; consumer area.</td>
</tr>
<tr>
<td>Croatia</td>
<td>Machine, subassembly industry.</td>
</tr>
<tr>
<td>Bosnia-Herzegovina, Serbia, Macedonia, Albania</td>
<td>--</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Chemical, food, metal industry; consumer area</td>
</tr>
<tr>
<td>Rumania</td>
<td>Chemical, machine, timber and food industry; consumer area.</td>
</tr>
<tr>
<td>Ukraine</td>
<td>--</td>
</tr>
<tr>
<td>Baltic Countries</td>
<td>Electronic, subassembly, timber industry; consumer area.</td>
</tr>
</tbody>
</table>

*Table 3.4: Regions in Eastern Europe*

### 3.5 Description of the Axes

#### 3.5.1 General Remarks

The infrastructure analysis analysed major railway and sea ship connections. Since this research project focuses on West-East corridors, the existing North-South corridors in Europe (partly also TEN corridors) were not considered.

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3 The TEN Corridor V (Danube) was excluded from detailed analysis.
The data collected is not of the same quality for all axes and regions (see also the information included in the Appendix).

### 3.5.1.1 Infrastructure

The following corridor descriptions are strongly focussed on questions concerning the development of intermodal transport. The infrastructure evaluation was carried out with particular focus on answering the following questions:

- Are there capacity problems on the existing railway line?. Problems are expected on single-track railway lines and on lines with steep vertical gradients.
- Does the railway line allow an average speed of 60 km/h for freight trains?
- Do intermodal terminals exist? Do existing terminals have capacity to handle more volume, or can additional capacity be added (renovation or new terminal construction) if market demand increases?
- Does the country have transport businesses with experience and/or interest in intermodal transport?
- Do seaports have equipment needed to handle containers?
- What is the status of the country’s rail regulation? Does it allow open access (compliant with actual EU regulations)?

From the perspective of China’s market situation, it is likely that there will be a huge transportation flow between Western Europe and East Asia on west-east railway lines, since the land route will become increasingly attractive. The Russian Railways (RZD) is actively promoting their trans-Siberian route for container transport. Furthermore, China and Kazakhstan, together with other Central Asian countries (former USSR) are strongly supporting the construction of a 1435mm gauge railway line along the old Silk Route from western China to the Caspian Sea or Iran\(^5\), where existing rail lines connect to Turkey and on to Bulgaria (and western Europe). The project seems to be serious (although with great risks) because the distance between west Europe and China on this route is shorter than via the Trans-Siberian Railroad and the Chinese market will grow enormously.

### 3.5.1.2 Transport Market and Intermodal Transport

Successful introduction of intermodal transport service depends on the following key indicators:

- Is there a general demand for intermodal transportation?
- Existing (or expected) transport flows suitable for intermodal transport. This depends on the region’s economic level;
- The relative cost of transportation by rail and road;
- The possibility of road transport (depends on the legal situation as well as the road network’s capacity and technical standards);
- Availability of intermodal terminals and knowledge of intermodal transport.

The market situation is described in chapter 3.2.

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\(^4\) Value is based on experiences with freight traffic (max. speed 100 km/h) on highly saturated rail corridors in Switzerland.

\(^5\) Initial decisions have already been made.
Generally, transport cost by truck is very low in Eastern Europe. While the level in Western Europe is about 1 €/truck km, in Eastern Europe it is less than 0.70 €/truck km. The reasons for this difference are lower fuel prices, lower personal costs as well as less regulation and truck controls.

Transport costs by rail in eastern Europe are also lower than in western Europe, but the difference is smaller than for road transportation, because eastern railway companies try to set western price levels for west–east transport as a result of their significant financial problems. The road network’s condition allows lower average transport speeds as one goes east. This is due to road quality and congestion caused by growing car traffic.

Availability of terminals is presented above. The knowledge of intermodal transport in Eastern Europe is not as high as in Western Europe.


![Map of Axis A](image)

Figure 3.2: Axis A (Source: [48]IVT)

3.5.2.1 Regions Connected

The Russian railway company (RZD) is promoting a landside connection from the USA (east coast by ship) to Far East via the Trans-Siberian Railroad. There is a group of businesses interested in this project including American, Scandinavian and Russian railway and ship companies as well as forwarders.

The European regions along axis A are Scandinavian Countries and Russia (Regions St. Petersburg and Moscow).

3.5.2.2 TEN Corridor

Corridor IX from Helsinki to Moscow
3.5.2.3 Infrastructure Characteristics

Railway Lines:

- Narvik – Haparanda: 1435mm gauge
- Haparanda – Moscow: 1524mm gauge

The existing rail link between Sweden and Finland is not heavily frequented and has capacity problems. An upgrading is planned to improve freight service between these two countries.

On the section St. Petersburg – Moscow future capacity problems are expected because of the increasing high-speed passenger traffic.

The main rail line from the Finnish border to Moscow is equipped and utilised in a different degree in its different sections. The section from the Finnish border to Vyborg is an electric single-track railroad line with a density of freight traffic of some 10 million tons (net) per year in both directions. The rest of the rail line is an electric double-track line.

Terminals:

In St. Petersburg, Tver, Zelenograd, and Moscow and in the suburbs of Moscow large intermodal terminals are under construction to be incorporated into the infrastructure of the transport corridor.

3.5.2.4 Railway Regulation Status

The Russian railway company RZD does not allow access to third transport companies. RZD is a state owned private company like DB and SBB and is organized in a similar way.

Finland is obliged to allow open access due to EU regulations. Some experts expect that RZD will try to use the Finnish rail infrastructure to reach the Helsinki seaports as well as the Swedish boarder. Sweden is one of the first European countries where railway privatization was introduced; its network also allows open access.

3.5.2.5 Market Situation

The Section between Finnish/Russian Border and St. Petersburg/Moscow passes through a number of Russian regions with highly developed industries, great and various raw materials and diversified agriculture. Here 8% of Russia’s agricultural output is produced. These regions include the cities of St. Petersburg, Novgorod, and Moscow. Approximately 13% of Russia’s industrial manufacturing is concentrated in the region and therefore the region has the potential for development of foreign trade activities. These industries include machine building and metalworking as well as chemical and petrochemical production. Besides food industry, electric-power industry, wood and the wood pulp and paper industries exist together with the industries of construction materials, glass and earth ware.

The area’s road network is in a condition not comparable with the one in Western Europe. Furthermore, some sections are heavily used, reducing the quality of freight transport.

A strong market potential may be expected for westbound exports as well as for imported consumer goods from Western Europe using intermodal transport.
3.5.3 **Axis B: North Sea Ports – Baltic Ports – Moscow – Trans-Siberian Railroad – East Asia**

![Map of North Sea Ports, Baltic Ports, Moscow, Trans-Siberian Railroad, and East Asia](image)

*Figure 3.3: Axis B (Source: [48]IVT)*

3.5.3.1 **Regions Connected**
- Dutch/German coast,
- Baltic countries,
- St. Petersburg area and
- Moscow area.

Waterway connections via Baltic Sea, 1524 mm railway from Baltic ports and St. Petersburg port to Moscow, instead of gauge change rail/rail at EU-Russian border.

3.5.3.2 **TEN Corridors**

**CORRIDOR IX FROM ST. PETERSBURG TO MOSCOW**

3.5.3.3 **Infrastructure Characteristics**

**Railway Lines**

Railway infrastructure in the Baltic countries is very similar to Russian infrastructure. The gauge is 1524mm and most of the lines are only single track, but there appears to be capacity for additional transport since Russian exports via Baltic seaports are declining as the country attempts to export its bulk goods (e.g. petroleum products) via Russian seaports in the St. Petersburg area.

The Baltic countries are making progress on privatising their railway system.

**Terminals**

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[^6]: The American railroad Wisconsin Central already owns the railroad company in Eastland.
No information was available concerning inland terminals (note that the distances between Baltic country seaports and Russian boarder are very short).

Seaports

The largest Baltic seaports have container handling facilities, but the main business of these ports is bulk cargo and ferry connections in the Baltic Sea. However, there is little doubt that they will expand their handling capacity when market conditions warrant.

3.5.3.4 Rail Regulation Situation

The situation is the same as for axis A. One option is that the Russian railroad, RZD, will try to operate its own trains directly to Baltic ports once open access is in place on Baltic country railroads.

3.5.3.5 Market Situation

The Baltic countries are small economic regions with good growth in different industry sectors. Therefore there is a growing market for intermodal transport for exports as well as imports of western consumer goods. The main role of axis B is its bypass function for the parallel onshore railway link (axis C). Axis B is most advantageous for transports between the Dutch and German North Sea ports and Russia, because in that case the number of transshipments is the same as on the rail link (i.e. vessel – vessel – 1524mm gauge railway using axis B compared to: vessel – 1435mm gauge railway – 1524mm gauge railway using Axis C).

3.5.4 Axis C: Berlin – Warsaw – Brest – Minsk – Moscow

![Figure 3.4: Axis C (Source: [48]IVT)](image)

3.5.4.1 Regions Connected

Axis C runs through the following regions:

- German North Sea ports
- Northern Germany
- Warsaw area
- Belarus
• Moscow area

3.5.4.2 TEN Corridors

Corridor II

3.5.4.3 Infrastructure Characteristics

Railway Lines

• Berlin – Malaszewicze/Brest: 1435mm gauge
• Malaszewicze/Brest – Moscow: 1524mm gauge

All railway lines are electrified double track lines. In Poland maximum speed is 160 km/h. Long sections without curves or curves with large radii also allow maximum speeds of over 100 km/h in Belarus and Russia. The capacity bottleneck on this corridor is the gauge change area of Brest. The tracks have not been maintained to western European standards, because the Polish railway company PKP has significant and long-running financial problems.

There appears to be capacity for additional transport on this line since the amount of transport from Russia to their former eastern European allies has declined. Belarus has especially large available capacity.

The German part of the corridor already provides TEN standard highway and railway links. The main project for the rail network is the expansion of the existing link rather than the construction of new ones. A high-speed railway line between Berlin and Warsaw is in the planning phase. The German section of TEN Corridor II is only of peripheral interest in the CODE-TEN project. The main interest is in Poland through which the largest section of the corridor passes and which also has interconnections with other corridors.

Terminals

Figure 3.5: Terminals along axis C
Terminals along axis C in Poland are located at: Warsaw, Pruszkow, Gadkj, Kobilinka, Plonsk, Malaszewice, and Lodz. Additional terminals mainly along or near axis D1 are located in Gliwice, Sosnowiec, Slawkow Plld., Krakow, Wroclaw, and Medyka. The main terminal operators in Poland are PKP and Polzug (an intermodal provider).

The Gdansk and Gdyna port terminals are not on Axis C, but can play a role in connecting axis C with axis B. Apart from these two, the capacity of Polish terminals is not high, but several sources state that terminals will be upgraded and new terminals constructed in the coming years.

Belarus has terminals in Brest and Minsk. Both terminals could serve as hubs for transport flows to the Ukraine, but they would need to be upgraded.

Russian terminals along the Axis C are located at Smolensk and Moscow.

Road Network

The existing road networks in Poland and Russia are not up to western European standards, however significant investments are expected for Poland’s road network in the coming years.

3.5.4.4 Rail Regulation Situation

Belarus and Russia are not subject to EU regulations regarding open access, which already exists in Poland. The three railroad companies Railion, PKP and RZD have a close cooperation on axis C, especially for consignments to and from Asia.

Problematic on this corridor are the inefficient transshipment and customs operations at the Poland-Belarus border (EU border) where operations are not up to best practices.

3.5.4.5 Market Situation

Poland is a medium important market for intermodal transport, but with great risks. Belarus is not likely to be an interesting market for intermodal transport at this time.

3.5.5 Axis D

A double axis system is defined as axis D in mid Europe from central and southern Germany to the East up to Ukraine and Romania.

Figure 3.6: Axes D1 and D2 (Source: [48]IVT)
3.5.5.1 Regions Connected

The following regions are connected by axis D1:

- UK/Northern France/Benelux
- Southern Germany
- Czech Republic
- Slovakia
- Southern Poland (region Katowice)
- Ukraine

3.5.5.2 TEN Corridors

- Corridor VI from Praha to Katowice
- Corridor III from Katowice to L’viv
- Corridor V from L’viv to Kiev

3.5.5.3 Infrastructure Characteristics

Railway Lines

The railway line in this corridor has a gauge of 1435mm to the Ukrainian border where it changes to 1524mm. The line is double track and electrified. Capacity problems exist in the greater Prague area, where dense passenger traffic exists. The quality of rail infrastructure is good, but in the Czech Republic and Poland it is definitely at eastern European standards. East of Prague capacities are not a great problem, due to the reduced Russian exports to former eastern European trading partners. The Czech railways are upgrading infrastructure on their main lines to Poland and Slovakia. Maximum speed of 160 km/h is currently possible or planned.

All lines along the axis are electrified but with many changes of electrical and signalling systems (the Czech Republic and Slovakia have lines with 3kV DC and 25 kV monophase AC with many change points, but dual voltage locomotives are in use.

The quality of the Ukrainian railway network is lower than the Russian. Also there is not much information available on future planning and investments on the Ukrainian rail network or the status of rail regulation changes.

Terminals

In the western part of axis D1 many terminals exist with high capacity. The North Sea port terminals are of special importance as points of origin or destination for traffic on this axis.

The following terminals are located on Axis D1:

- Czech Republic: Plzen, Prague, Pardubice, Brno, Ostrava
- Poland: Gliwice, Sosnowiec, Slavkov Pld., Krakow, Medyka
- Ukraine: L’viv, Kiev

The main terminal operators in the Czech Republic are: CSKD-INTRANS, Metrans, Contrans and CSPL. Terminals in the Prague and Southern Poland areas are well-developed with good infrastructure. For more information on terminals in Poland see also chapter 3.5.4.3.
3.5.5.4 Rail Regulation Situation
The Czech Republic and Poland are subject to EU regulation on open access, while the Ukrainian network will also in the future remain closed for new entrants.

3.5.5.5 Market Situation
The road network on the western branch of the axis (including Czech Republic) is of generally good quality and capacity, further east roads are of lower quality and have capacity problems. A bottleneck also for road transport is the eastern border of the expanded European Union.

The Czech Republic has a well-developed consumer goods industry and is westward oriented with respect to export of products. Southern Poland is a region traditionally oriented to the coal and steel industry.

Axis D1 establishes a connection of Northern and medium Western Europe with the fast growing industrial cluster (part of Czech Republic, southern Slovakia, western Hungary) with a high and permanently growing freight transport demand.

Axis D2 – Basel – Arlberg – Vienna – Budapest – Bucharest

3.5.5.6 Regions Connected
The following regions are connected by axis D2:
- South-East France
- Southern Germany
- Switzerland
- Austria
- Slovakia
- Hungary
- Romania

3.5.5.7 TEN corridors:
CORRIDOR IV FROM BRATISLAVA TO BUCHAREST

3.5.5.8 Infrastructure Characteristics
Railway Lines
Several different railway lines providing alternative routes serve this axis. The railway lines are of 1435mm gauge with high or medium capacity (some mountain lines and single track sections). All the lines are electrified, but they have many changes in electrical and signalling systems.

In Austria the “Westbahn” will be upgraded with a second track on the Arlberg section and several new line sections east of Salzburg to allow increased speed and/or higher capacity. The “Ostbahn” from Vienna to Budapest is a main line built and operated to western standards. Railways in eastern Hungary as well as Slovakia’s rail infrastructure are also in good condition. In Rumania the railway from Arad to Bucharest has the typical problem of east European railways: a maintenance deficit.

Terminals
The eastern section of the axis contains the following terminals:
Strategies for Increasing Intermodal Transport between Eastern and Western Europe

- Austria: Vienna
- Slovakia: Bratislava
- Hungary: Sopron, Győr, Budapest, Budafok-Haros (in Budapest), Kiskundorozsma, Zahony
- Romania: Scolnok and Bucharest

Terminal capacity on axis D2 is better than on the other axes. Sopron is an important point, because (apart from serving the Hungarian market) from here eastbound connections are operated to Bucharest, Istanbul, Saloniki, and Skopje as well as into the Russian Federation states via Zahony in the east of Hungary. Furthermore BILK (Budapest Intermodal Logistic Centre) is a new terminal, owned by railways and intermodal operators, playing an important role as a gateway to the east.

All intermodal terminals in Hungary are partly or fully owned by the Hungarian Railways or its subsidiary. The terminals are mainly internationally oriented. Scheduled lines are also available, however there is substantial available capacity in all the terminal lines. Moreover, all the terminal operators are willing to expand their service in order to meet a potentially higher market demand.

**Waterway**

Budapest’s port provides a close connection between the Danube and the railway network for intermodal transport.

**Road Network**

Roads on the western branch of axis D2 (including Western Hungary) are of good quality and capacity, while further east they are not up to EU-standards and have capacity problems.

**3.5.5.9 Rail Regulation Situation**

Within the EU countries open access is possible or must be allowed in the coming years. It is expected that it will be introduced soon in Romania (EU candidate country).

**3.5.5.10 Market Situation**

Axis D2 connects Northern and central Western Europe to the fast growing industrial cluster (part of the Czech Republic, Southern Slovakia, Western Hungary). This axis has a high and growing amount of freight transport. Budapest is increasingly becoming a hub for intermodal transports to the east. The market in Romania is difficult, but it is also expected to have a growing potential. Axes D1 and D2 can be seen in the future also as a connection with the Black Sea and nearby countries.

---

7 Direct trains already run between Western Europe and Hungary using multi current locomotives.
3.5.6 **Axis E: Lyon – Turin – Venice – Ljubljana – Belgrade – Bucharest/Sofia/Greece**

![Map of Axis E](image)

*Figure 3.7: Axis E (Source: [48]/IVT)*

### 3.5.6.1 Regions Connected

The following regions are connected by axis E:
- Portugal/Spain/Southern France
- Switzerland/Northern Italy
- Austria
- Slovenia
- Croatia/Hungary
- Bulgaria/Romania
- Greece

### 3.5.6.2 TEN Corridors

- Corridor X
- Corridor V from Venice to Ljubljana
- Corridor VII from Belgrade to Bucharest

### 3.5.6.3 Infrastructure Characteristics

#### Railway Lines

The railway lines on this axis are generally in a good condition in the sections west of Belgrade where they are mainly double track lines of high or medium quality (mountainous lines); to the east of Belgrade the lines are of lower quality. Most lines are electrified. There is an interoperability problem with the Iberian countries’ gauge of 1667mm.

East of Slovenia, especially in Serbia, railways are in a bad state of repair, and the capacity of rolling stock is limited following the long war in the region.

A capacity problem may be the single-track mountainous line between Nis and Sofia, which is an important route to Bulgaria and via Sofia to Turkey. In Bulgaria a railway investment...
program financed by EU exists and is helping the Bulgarian railways to upgrade their railway infrastructure.

From Venice to the Slovenian border via Trieste (Villa Opicina) the railway line currently has a double track but with many capacity limitations. These limitations are caused by the track conditions and the signalling systems as well as the overlapping of different transport flows along the line: traffic from the port of Koper (which has one of the highest rail transport proportion of European ports) and the main line between Italy and the Balkan Peninsula.

**Terminals**

The axis contains the following terminals:

- Slovenia: Celje, Koper, Ljubljana\(^8\), Maribor, Novo Mesto (The country has a high terminal density.)
- Hungary: Sopron, Györ, Budapest, Budafok-Haros (in Budapest), Kiskundorozsma, Zahony
- Croatia: Zagreb
- Serbia: Belgrade
- Bulgaria: Sofia freight, Plovdiv–Philipovo, Dimitrovgrad, Stara Zagora, Tchestovo freight, Pleven West and Vratza

**Seaports**

The Bulgarian seaports of Varna and Burgas have container-handling facilities and are gateways to the Black Sea area.

**Road Network**

The road network west of Croatia has good capacities. East of Croatia there are many problems with the road network following war destruction and traffic controls by UN forces. Otherwise road transport price levels are lower than in other Eastern European countries.

**3.5.6.4 Rail Regulation Situation**

The TEN Corridor X today is unique since the countries and rail infrastructure companies have founded an association in 2001 – “Arbeitsgemeinschaft” (ARGE Korridor X) – responsible for an active corridor management.

From the infrastructural point of view, the pan-European multimodal corridor X runs along a route that cuts diagonally through central and south-eastern Europe, crossing Austria, Slovenia, Croatia, the Yugoslav Federation and Macedonia, ending up in the terminal of Saloniki.\(^9\)

It is not clear if open access will be introduced east of Slovenia and Hungary in the coming years. The EU candidate countries Bulgaria and Romania will align their railway regulation at EU level until end 2006.

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\(^8\) This terminal is owned and operated by the Slovenian railway company and the port of Koper and is planned to be upgraded in the next years.

\(^9\) Several branches are also part of corridor X establishing interconnections between the single Balkan areas areas: Graz-Maribor-Zagreb (Axis A), Budapest-Novia Sad Belgrade (Axis B), Nis-Sofia (Axis C, with an extension along TEN Corridor IV: Dimitrovgrad-Istanbul) and Veles-Bitola-Florina (via Egnatia-Igoumenitzia; Axis D)
3.5.6.5 Market Situation
Slovenia, Croatia and Bulgaria are interesting markets with a high rate of growth. The other former states of Yugoslavia have a very low economic level, but the chance of growth exists. In the coming years it is expected that this axis will have high potential concerning transport flows from and to Turkey and eastwards, supported by the planned Silk Road transport projects (The Bosporus rail connection is currently under construction).

3.5.7 Axis F: Spanish Mediterranean seaports – Gioia Tauro – Black Sea – Costanza/Varna /Odessa/Sevastopol

Figure 3.8: Axis F (Source: [48]/IVT)

3.5.7.1 Regions Connected
The following regions are connected by axis E:

- Portugal/Spain
- Southern Italy
- Greece
- (Turkey)
- Bulgaria/Romania/Ukraine/Donez area (Russia)

The Mediterranean route is an alternative to several land routes with high quality ports in Western Europe and medium quality ports in Eastern Europe. This route connects the following ports and hinterland terminals: Barcelona, Valencia, Gioia Tauro, Athens, Thessaloniki, Sofia, Varna, Constanza, Bucharest and Odessa.

3.5.7.2 Infrastructure Characteristics

Seaports
The most important seaports on this axis are:

- Odessa (Ukraine): largest seaport on the Black Sea, with a large volume of containerized cargo. Operator is the Hamburg Port Consulting. The transshipment volume in 2004 was about 200,000 TEUs. The port has direct access to TEN Corridor IX and within to Kiev (and Moscow).
- Constanza (Romania) is building a new container terminal with a yearly capacity of 800,000 TEUs (in 2000: transhipped volume 60’000 TEUs). Constanza is consolidating
its role as a logistic node towards the Caucasus and central Asia region and is directly connected with axis D2.

- Varna and Burgas (Bulgaria) are also important ports with container handling equipment and are directly connected with axis E.

3.5.7.3 Market Situation

Short sea shipping is a good and cost reasonable alternative to landside transport especially for the transport flows between the Iberian Peninsula and Eastern Europe.

3.5.8 Corridor Summary

3.5.8.1 Rail Infrastructure

The Eastern European railway network is in a lower state of repair than in Western Europe. The upgrading and construction of new infrastructure for intermodal freight transport is included in the transport investment programme of all eastern European countries. The development of environmentally friendly intermodal freight transport is one of the key transport policy priorities for these countries.

3.5.8.2 Terminals

In general, most of the intermodal terminals in the eastern part of the EU are old. In Poland however, as part of privatisation, which has occurred since 1990, several terminals and handling equipment have been renovated according to modern standards in order to serve continental intermodal transport.

Another positive exception is Budapest where a modern intermodal freight transport terminal (BILK) exists since 2003. This terminal should be used as best practice example in more places to cope with the growing needed capacity in the future. It is expected that new terminals will be built and old terminals renovated when market conditions warrant.

The regional coverage rates of existing terminals in Eastern Europe are lower than in Western Europe, but in general most important regions have terminals.

3.5.8.3 Rail Regulation Situation

Open access and thus the possibility to cooperate with private railway operating companies are or will soon be an interesting option in all EU countries. The Russian and Ukrainian 1524mm gauge network will also in the future be operated by state owned companies.

3.5.8.4 Market Situation

In general today’s low price level for road transport is a hindering factor for the development of attractive intermodal freight transport services. Nevertheless currently new EU regulations on road safety are being developed. Furthermore it is expected that the labour cost level will slowly approximate western levels.

3.5.8.5 Summary of Axes

Table 3.5 summarizes important information about the six axes.

Finally, it should be emphasized that between the axes there are many interconnections north-south with a similar state of infrastructure as the east-west axes. For example, the axis from the Baltic countries – Poland Czech Republic/Slovakia – Hungary – Slovenia is an important route connecting axes A to E.
<table>
<thead>
<tr>
<th>Axis</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis A</td>
<td>This axis is important for transport flows to/from Asia and between Russia and America. No further priority for intermodal strategies.</td>
</tr>
<tr>
<td>Axis B</td>
<td>This axis is important for America oriented Russian transport flows via North Sea ports. It would appear to have relatively low priority for European intermodal transport flows. Existing European intermodal boxes are not suitable for sea transport, but cargo on pallets plays an important in logistic chains of European consignors. No further priority for intermodal strategies.</td>
</tr>
<tr>
<td>Axis C</td>
<td>This axis is important for Poland and Russia. The existing cooperation of PKP and RZD with Railion has established an almost monopolistic position on this corridor. No further priority for intermodal strategies, except a strong cooperation with this trust is an option.</td>
</tr>
<tr>
<td>Axis D</td>
<td>This axis is very important especially concerning the car industry cluster Czech Republic – Slovakia – Western Hungary and in providing access to Romania and Bulgaria. A problem is the great number of borders between countries and railway companies. The railway interoperability and its technical implementation are important. In theory the EU laws are in force, but technical and financial bottlenecks still exist. An efficient intermodal service needs hub terminals for an efficient distribution of transport flows between west and east. First steps in this direction have been made as part of Budapest's BILK terminal.</td>
</tr>
<tr>
<td>Axis E</td>
<td>This axis is important for serving new markets in the Balkan region. Ljubljana could be a hub on this axis. Furthermore axis E can be a good connection to Bulgaria, Greece and Turkey. Railway infrastructure suffers partly from demolition after the war, but the TEN Corridor X activities are very encouraging for the future.</td>
</tr>
<tr>
<td>Axis F</td>
<td>Special case (waterway corridor).</td>
</tr>
</tbody>
</table>

*Table 3.5: Summary of axes*
4 Theory of Strategies

4.1 Introduction

Logistics play a central role in any company’s management and control processes. In many cases the logistic management is split into three principal tasks and outsourced to external specialists:

1. Organization and transport management (forwarders);
2. Haulage (carriers);

The major logistic specializations are shown in Figure 4.1. Companies have to mix specialities according to the markets, but the level of specialization can be chosen according to the company’s strategies.

![Figure 4.1: General Logistic Strategies](image)

4.2 Business Strategies

In the intermodal transport business determining the best business strategy is very important, because today many companies are operating more or less independently in different subprocesses, which makes the management of the whole transport process from door to door
often very complicated. The splitting of the process into a number of companies is the result of the historic development of north-south oriented intermodal transports across the Alps.

The splitting of the business has following cons:

- Information management is difficult;
- Responsibility for quality towards the customer is a problem for different partners in the transport chain;
- A European wide network is not possible or does not exist (instead single point to point connections are established).

Today, in order to avoid such quality problems, international services are being offered in some cases by one single railway operator (e.g. SBB Cargo between Germany and Italy).

A clear strategy concerning information, quality management and network building is essential for the success of starting a new intermodal business on one of the east-west axes in order to penetrate the fast growing markets of Eastern Europe. Furthermore it is important to keep in mind the specific legal and transport operations situation in Eastern European countries (both the new EU countries and non EU countries).

Business strategies concerning processing depth are:

- **Functional Oriented Specialist:** This category includes terminal operators (e.g. D USS), intermodal providers (e.g. Kombiverkehr), and main-haulage operators (e.g. R4C). The benefit is to work in a core business with high expert competences and productivity gains.
- **Sector Specialist:** This category consists of industry type or trade oriented experts, who operate in the proximity of consignors with a profound experience in certain industry sectors. They offer services over the whole transport chain or over the whole value-added chain. *A typical example is the specialist for chemical transports “Bertschi AG” (CH).*
- **Full Service Operator:** This type of operator offers integrated transport solutions to consignors from different business sectors. This does not mean that all services need not be produced in-house; certain processes may as well be outsourced to subcontractors. *The Swiss intermodal provider Hupac is making progress towards an integrated transport organisation, but so far the pre and post haulage management is not part of the business.*

Business strategies concerning geographical areas are:

- Networks along a single line or corridor;
- Networks in a limited area or zone;
- Networks in a widespread area.

### 4.3 Market Strategies

Market strategy decides, which freight segments in which geographical areas a logistic provider should focus on. A set of criteria is needed to identify and evaluate relevant market segments. The following market segmentations are possible:

- **Nature of the Good:** This attribute include value, volume, weight, physical conditions and sensitivity. Those factors determine the goods’ logistic requirements, value and the need for special equipment being especially important.
• **Consignment Dimension:** Consignments can be sent in full loadings (truck/rail wagon/ITU), as part load or as groupage freight transports.

• **Time Attributes:** include duration, regularity and reliability of transport.

• **Geographical Attributes:** These include transport distance and relation as well as the coverage of the area.

• **Degree of Logistic Integration:** This attribute includes the nature and complexity of transport related ancillary services and amenities.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Measurement Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Good</td>
<td>Low sensitivity, low value</td>
</tr>
<tr>
<td></td>
<td>High conditioning, high value, need for special equipment</td>
</tr>
<tr>
<td>Consignment Dimensions</td>
<td>Full load</td>
</tr>
<tr>
<td></td>
<td>Part load</td>
</tr>
<tr>
<td></td>
<td>Groupage freight</td>
</tr>
<tr>
<td>Time Attributes</td>
<td>Regular, but unhasty</td>
</tr>
<tr>
<td></td>
<td>Non regular, express transport with guaranteed time</td>
</tr>
<tr>
<td>Geographical Attributes</td>
<td>Long distance, axis oriented, point to point</td>
</tr>
<tr>
<td></td>
<td>Short distance, large collection and distribution area</td>
</tr>
<tr>
<td>Degree of Logistic Integration</td>
<td>Purely transport</td>
</tr>
<tr>
<td></td>
<td>Complex logistic offer</td>
</tr>
</tbody>
</table>

Table 4.1: Freight Segments

<table>
<thead>
<tr>
<th>Logistic Requirement</th>
<th>Nature of good</th>
<th>Statistical Freight Group&lt;sup&gt;10&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low value</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bulk freight</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Easy handling</td>
<td>5</td>
</tr>
<tr>
<td>Medium</td>
<td>Bulk cargo with higher value or semi-finished good for industry</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Transport safety important</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>High</td>
<td>High value</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>General cargo</td>
<td>7/9</td>
</tr>
<tr>
<td></td>
<td>High distribution effort</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Need for value preservation</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2: Freight Group Segmentation

<sup>10</sup> Classification based on Swiss Freight Transport Statistics - GTS
### Table 4.3: Freight Groups (Source: Swiss Freight Transport Statistics – GTS)

<table>
<thead>
<tr>
<th>Number</th>
<th>Freight Group</th>
<th>Logistic Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agriculture and forestry products</td>
<td>Low (except animals (13): high)</td>
</tr>
<tr>
<td>2</td>
<td>Food and animal feed</td>
<td>Medium (except animal feed: low)</td>
</tr>
<tr>
<td>3</td>
<td>Combustible and fuels</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>Ore and semi-finished metal</td>
<td>Low</td>
</tr>
<tr>
<td>5</td>
<td>Minerals and building materials</td>
<td>Low</td>
</tr>
<tr>
<td>6</td>
<td>Chemical basic materials and products</td>
<td>Medium (except hazardous products: high)</td>
</tr>
<tr>
<td>7</td>
<td>Different products (machines, glass, metal products)</td>
<td>Medium or high, different products</td>
</tr>
<tr>
<td>8</td>
<td>Waste</td>
<td>Medium, some low</td>
</tr>
<tr>
<td>9</td>
<td>Other goods (known or not known e.g. intermodal transport units)</td>
<td>Normally high (especially ITU)</td>
</tr>
</tbody>
</table>

### 4.4 Operational Strategies

The purpose of a production strategy is to develop a plan for transporting some good or product from a consignor to a consignee at an optimized level of efficiency.

### 4.4.1 Transportation Processes

A transport process (or transport chain) consists of a number of sub-processes, depending on the type of transport chain.

\[\text{Figure 4.2: Transport Chain Types}\]
It is important to consider that the intermodal transport chain contains the greatest number of processes (including ancillary processes), namely:

- **Pre- and post-haulage**: by truck (or by train in case of major consignors equipped with private sidings);
- **Terminal transshipment**: at least 2 transshipment processes per transport;
- **Main haulage**: by train (different operational strategies possible);
- **Equipment leasing**: ISO containers are always leased (mostly by shipping companies); in Europe swap bodies can be leased by different companies or are owned by forwarders for closed transport chains.
- **Information management**: for an optimal transport chain organization the information management is essential. The more processes have to be integrated the more difficult it becomes to have the necessary information available at the right time and place.
- **Goods safety**: depending on the consignments’ characteristics safety disposition is needed for security reasons during transport (theft, damage) and/or to prohibit environmental damages (hazardous goods).
- **Finance**: services must be paid for.

### 4.4.2 Production Process Variation in Intermodal Freight Transport

The three main processes in the intermodal transport chain are: pre- and post-haulage, terminal transshipment and main haulage.

#### 4.4.2.1 Pre- and Post-Haulage

There are 2 variants for pre- and post haulage:

- **Self-Service**: A company (or freight forwarder) delivers or picks up transport units to and from the intermodal terminal with its own trucks or with a subcontractor trucking company.
- **Delivery Service**: The terminal operator or his subcontractor picks up and delivers intermodal boxes at the consignor’s (or consignee’s) address.

#### 4.4.2.2 Terminal

A single operator is generally responsible for the entire terminal process. A separate operator may in some cases handle the storage and the leasing process of empty boxes.

#### 4.4.2.3 Main-Haulage

There are several different operational strategies for rail main haulage. Normally intermodal trains are operated separately from other rail freight transport (wagonload transport).

The simplest type of main haulage is the direct train (*e.g. mail operation*) that consists of a direct train between two terminals. This is the most efficient operation system for moving full trains between the loading and delivery locations, but it lacks the benefit of networking and therefore this service can only be offered between a small number of large terminals located in agglomerations with a large freight demand.

Therefore, several alternative operational strategies have been developed to increase the coverage of the market. The different types of operating strategies are summarized below:\(^{11}\):

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\(^{11}\) Source: IVT
Direct Train

Block trains with variable number of wagons, shuttle trains with fixed number of wagons.

Pros:
- Low production costs
- Short transport time (overnight > 500km)
- High capacity per train

Cons:
- Needs high demand between two regions
- Long average distances for pre- and post-haulage
- Network of intermodal offers not possible
- Not useful for less dense market areas

Feeder System

Main trains as well as feeder trains normally are shuttle trains. Smaller terminals can also be connected with a great terminal. The distance where two trains run should be a small part of the entire haulage (<100km).

Pros:
- Connecting smaller terminals in less dense market areas
- Short transport time (time loss for coupling and splitting 10-20 min)

Cons:
- Higher train costs on a part of the run (short trains)
- High requirement for train punctuality
Strategies for Increasing Intermodal Transport between Eastern and Western Europe

Liner Train System

Pros:
- Connecting smaller terminals in less dense market areas
- High wagon km use (liner-trains run day and night)
- Network building possible

Cons:
- Extensive use of loading capacity
- Longer transport time
- Terminals must be able to tranship very fast to minimise stop time.

A liner-train is a shuttle train connecting a number of terminals. Distance between terminals 100-150 km.

Hub and Spoke System

Pros:
- Connecting more terminals
- Useful for smaller terminals, because one train carries boxes for different other terminals
- Network system (different hubs & spokes can be connected)

Cons
- Longer transport time
- High requirement for train punctuality
- Additional transshipment
- Hub terminal needs high transshipment capacity and needs 1 loading track per train
- Bad capacity use of hub terminal

Spoke-trains are shuttle trains running between two terminals via a hub. At the hub all trains arrive at the same time, then boxes are transferred from train to train in a short time. With a Hub and Spoke system, all terminals participating at a hub are connected with each other.
Intermodal Transport integrated in a Wagonload Transport Network

Wagonload concepts can also be used for intermodal transport.

Pros:
- Existing offer
- Small terminals can be connected
- Network system

Cons:
- Long transport time (shunting)
- High costs (shunting)

Conclusion

Feeder, liner and hub & spoke systems allow rail operators to replace connections with direct trains, if transport demand allows it. These operational strategies have fewer risks for introducing new transport services, because the minimum demand necessary is lower (than for direct trains).

The choice of an appropriate strategy depends on the following market considerations:
- Quality of transport (main haulage transport time, departure/arrival time, punctuality, frequency of service);
- Coverage of the area (number of point-to-point connections).

Today main haulage is mostly operated using direct or shuttle trains due to their cost effectiveness. There are also some examples of feeder systems in operation.

There are no examples of liner-trains in operation currently, although they are being considered. One reason is the lack of possibilities for building up intermediate terminals with high capacity for a short train stop time while maintaining low operating costs. In the EU research project INHOTRA (5th program) transshipment equipment was developed.

The hub & spoke system is the optimal way to build up networks in a widespread area. Still only one intermodal hub and spoke system was operated in Europe (ICF hub in Metz/France with wagon shunting), but this was closed in 2004 for economic reasons (infrastructure charges in France). However, intermodal hubs in their proper sense (no pre and post haulage operation) so far never existed. The high capacity crane systems needed for a hub are expensive but used only for a few hours during the night. Therefore, in order to increase the facility’s profitability a hub must be used during the day also for local/regional traffic.

4.4.2.4 Box leasing

There exist two general strategies for box leasing:
- Allocation of boxes is the responsibility of the consignor (the person shipping goods either owns boxes or leases them from a specialised company).
- Allocation of boxes by a forwarder or a transport provider.

Today both of these strategies are in use.

4.4.2.5 Information Management

A reliable and flexible information management is essential for high quality in intermodal transport, because it establishes the logical interfaces between the processes of the transport
chain. The more processes to be coordinated, the more complex but also important the system becomes. A loss of information at an interface is expensive and time-consuming to recover, or otherwise leads to quality and productivity reductions.

Therefore the information systems have to be planned carefully right from the beginning when establishing and organizing a intermodal transport chain.

4.4.2.6 Good Safety

The goods safety process depends on the transport relation and consignment characteristics. It is an important aspect of the business strategy (sector specialists).

4.5 Strategic Possibilities for Logistic Suppliers

4.5.1.1 Market Strategies

For logistic suppliers the market strategy choice primarily depends on the possibility to find a sufficient number of ITUs per day/week to transport with economic operation concepts (see operational strategies).

4.5.1.2 Operational Strategies

Operational strategies depend strongly on the volumes to transport. In order to build an intermodal transport service network a wide diversification of the market is needed (no specialised nature of goods as well as no geographical concentration). A geographical or nature of good specialisation allows only services between dedicated terminals.

4.5.1.3 Business Strategies

The choice of the business strategy for logistic suppliers depends on the market strategy and the ability to attract a sufficient volume to transport with efficient operation concepts.

A special problem is the processing depth of companies involved in intermodal transport. The following lessons are available from the existing practise of north – south intermodal transport:

Splitting the business into different companies for different sub-processes of a intermodal transport chain is very problematic, because:

- It is difficult for consignors to find the transport service,
- Interfaces between sub-processes need strong management and increase costs and problems,
- Different partners in the transport chain lead to problems concerning responsibility to customers.

Today the greatest share of intermodal transport volume is dominated by a small number of companies (large road transport companies, large and specialised logistic suppliers). Most consignors don’t find the way to intermodal transport.

Intermodal transport west – east should be organised by full service operators who are responsible partners with their customer. This will make intermodal transport service simpler for the customers than it is on the north – south transportation axes today. This does not mean that a logistic supplier must be an owner of terminals, a private railway company and a trucker company, but rather that the coordination between involved companies must be stronger and one company must have the lead of the whole transport chain as responsible carrier.
5 Market Potential and Transport Costs

5.1 Market Analysis

5.1.1 Introduction

In addition to cost (see Chapter 4.2), the decision to offer intermodal transportation in a given market critically depends on actual and/or potential freight transport volumes. More specifically, it is necessary to estimate the amount of existing cargo that could be carried by intermodal transport in the examined market without problems and whether it’s worthwhile to build up new transportation infrastructure to enable intermodal transport services. An essential precondition is to have sufficient potential transport volumes in either direction (including triangular relations, loops etc) in order to avoid cost generating empty wagon movements.

5.1.2 Data

The foreign trade statistics for European Union member states from Eurostat\(^\text{12}\) were used to analyze the status quo of intermodal transport between Western and Eastern Europe. Based on the results of the countries analysis in chapter 2 (see Table 3.5), this detailed market analysis is limited to the regions related to Axis D, which proved to be the corridor with the most favorable conditions for future intermodal transport. The analysis covers all countries between France, Switzerland and Germany in the west and the Ukraine, Romania and Bulgaria in the east.

The Extra-EU trade data is collected from custom formalities. The Eurostat data for Intra-EU trade only includes information from companies asked to provide information to tax authorities in the individual member states. Companies asked to provide information are generally large firms, which provide data on their output using measures developed by the EU and which pass on the data so obtained. The data from the national statistics offices are harmonized by Eurostat using a uniform methodology and placed in the COMEXT\(^\text{13}\) database. The data are complete since 1995 for each goods category (up to the finest level of the CN, see below) and for all months.

The individual goods are classified in the combined nomenclature (CN), which is based on the international nomenclature of the harmonized system (HS) for the designation and coding of the goods. This nomenclature is applied to all data collected on goods flowing to and from the EU, and within the EU individual member states. The use of a common and well-documented system allows goods volume data to be compared easily, even if the volumes were gathered by an other nomenclature then CN and have to be harmonized first.

The combined nomenclature (CN) consists of an eight-level organization of individual goods, which grew over the years from the different data systems (catalogs) of individual member states. The first two levels of the data system are presented in the appendix for all the goods classes.

5.1.3 Methodology

In order to evaluate the market potential for intermodal transport, the goods categories used in the data on total freight transportation described above (CN/HS), were analyzed to determine

\(^{12}\) EUROSTAT: Statistical Office of the EU
\(^{13}\) COMEXT: Intra- and Extra-European Union Trade by EuroStat
if goods in that category could be transported via intermodal transport. The following four criteria were used to make this determination:

- It must be possible to transport the goods in ITUs.
- No bulk goods (e.g. cereal grains)
- No goods that can be transported by unit trains (e.g. coal)
- No goods that require quick transport (express goods)

Goods categories, which cannot be classified clearly as transportable by intermodal transport, were also excluded from consideration in the market analysis.

The categories of goods, that were considered appropriate for transport by intermodal transport, are listed in Annex 4.

### 5.1.4 Results

Following countries were considered to determine the market potential on Axis-D:

<table>
<thead>
<tr>
<th>COMEXT Data Available</th>
<th>No COMEXT Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Switzerland</td>
</tr>
<tr>
<td>France</td>
<td>Bulgaria</td>
</tr>
<tr>
<td>Poland</td>
<td>Romania</td>
</tr>
<tr>
<td>Germany</td>
<td>Ukraine</td>
</tr>
<tr>
<td>Czech Republic</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td></td>
</tr>
</tbody>
</table>

*Table 5.1: Evaluated Countries*

The following figures present the actual volume (year 2004 in thousands of tons) of freight suitable for intermodal transport between the countries listed.
Figure 5.1: Potential volume for intermodal transport (direction west-east, France not included)

Figure 5.2: Potential volume for intermodal transport (eastbound exports from France)
Figure 5.3: Potential volume for intermodal transport (direction east-west, France not included)

Figure 5.4: Potential volume for intermodal transport (westbound imports into France)
The values indicated must be considered to be approximate for the following reasons:

- The selection of goods categories that can be moved by intermodal transport differs depending on point of view and system definition. For this analysis we tried to make a realistic selection and, in case of doubt, did not include the goods category.
- The quality of the existing data varies with each individual EU member country, especially because they use slightly different methodologies for collecting data from enquired companies (see chapter 5.1.2). This means that commodity flows from a certain number of "samples" are projected, and therefore the export value of a given country can be different from the according import value of all the other countries.

The transport volumes presented in the figures correspond to the actual transported freight tonnages for 2004, independent of transport modes. In estimating the market potential for intermodal transport, it is assumed that never all of these goods could be moved by intermodal transport. This is because, in most cases, even when given consignments should (logically) be made by intermodal transport, it is often not worthwhile to use intermodal transport due to the lack of a network and/or inability to consolidate consignments (i.e. freight groupage).

An important result is the balance of volumes transported from west to east and vice-versa. Apart from a few exceptions the volume difference between two countries in either direction does not exceed 25%. Therefore we state that in case of Axis D the precondition mentioned in the introduction of this chapter (equalized commodity flows) is fulfilled.

The determination of the future freight volume for intermodal transport is linked to an assumption for the modal split of the intra-European freight traffic and depends on economic growth in Europe. These factors have to be considered in further analysis.

### 5.2 Cost analysis

This chapter presents a cost analysis for transport activities on international routes between Eastern and Western Europe focusing on the D1/2 axes system described in chapter 2.4. Note that the analysis is based on production costs (not prices), i.e. the costs an operator has to calculate for transporting a consignment himself without subcontractors.

One of the main problems with intermodal transport is that it is not competitive with road transport on similar routes. The cost analysis presented in this chapter compares cost factors in the intermodal and road transport sectors to illustrate the disadvantages of and potential for intermodal transport in a growing and changing freight transport market.

The transport cost factors considered in this analysis depend on many parameters. Several parameters (e.g. tax regulations) depend on external conditions and cannot be directly influenced by the transportation sector. Furthermore, general conditions vary significantly between countries, which means that the values for cost factors can only be specified for the special cases. Therefore, for purposes of this analysis, a series of specific examples were created and considered under different scenarios. This allowed us to better understand the influence of specific parameters on transport costs.

Two analyses were completed: the first analysis (status quo analysis) considered existing costs and conditions, the second (prognosis) considered how total costs would change if specific assumptions or values of certain cost elements were to change (e.g. if fuel costs were to increase). This allowed us to better understand the influence of these factors on future demand for intermodal transport.

Finally, it should be understood that the specific values described below depend on the particular examples evaluated and therefore are not directly applicable to other routes. However, the overall results are believed to be descriptive of the general situation.
5.2.1 Scenarios

The analysis compared the door-to-door cost of making a consignment via intermodal transport (rail/road) and road-only transport for several different shipping scenarios. Since the single cost elements were calculated, the margins for the road haulier or the intermodal operator respectively have to be added in order to calculate the “all-in” price for the forwarder.

It considered two basic scenarios: the first was a haulage that required both pre and post haulage for the intermodal transport (by definition there is no pre and post haulage for the road-only transport mode), while the second required only post haulage for the intermodal alternative (i.e. containers could be directly loaded on to the train without being picked-up by truck; the example considered consignments from a seaport).

Several different variations were tested for each of the basic scenarios. For the first scenario (requiring pre and post haulage) the following scenarios were tested:

1. In order to analyse the impact of transport distance on costs, three representative routes on axis D were evaluated:
   a) Frankfurt/Main (D) – Praha (CZ): ca. 500 km;
   b) Frankfurt/Main (D) – Krakow (PL): ca. 1000 km;
   c) Frankfurt/Main (D) – Kyïv (UKR): ca. 2000 km.

2. In order to analyze the impact of single versus multiple pick-ups and drop-offs in the road-only transport alternative, the three distance scenarios 1-a, 1-b, and 1-c were analysed for
   a) A haulage consisting of a single full truck load from origin to destination;
   b) A haulage consisting of two half loads from different origins to different destinations, the two clients located approximately 50 km apart at the origin and destination ends of the haulage.

3. In order to analyze the impact of pre and post haulage distance in the intermodal transport alternative, the three main haulage distance scenarios were analyzed for:
   a) Pre and post haulage distance of 20 km.
   b) Pre and post haulage distance of 50 km.

4. In order to analyze the impact of additional transshipment the intermodal alternatives were analyzed for two cases:
   a) continuous main haulage;
   b) interrupted main haulage (assuming that the central hub is located approximately half way and that the container must be stored at the hub because a direct transshipment from train to train is not possible (as is normally the case)).

Finally, under the second basic scenario (no pre haulage), two distance alternatives were analyzed assuming that in the intermodal alternative there would be no transshipment and that post haulage distance was 50 km, and in the road-only alternative there would be full loads. This scenario represents the common case of seaport hinterland traffic where the train or the truck is loaded directly from the ship/terminal and therefore a landside pre haulage process is not necessary. In this case, the following routes were chosen:

   a) Rostock (D) – Poznan (PL): ca. 500 km;
   b) Bremerhaven (D) – Katowice (PL): ca. 1000 km.
In summary, the study evaluated eight road-only transport scenarios and 14 intermodal transport scenarios (12 with pre and post haulage and two with only post haulage). Figure 5.5 provides an overview of the scenarios.

Figure 5.5: Scenario overview

5.2.2 Cost elements

The cost analysis considers only operational costs. In other words it is assumed that the necessary investments in the infrastructure and the transport boxes have already been made. Furthermore, since the infrastructure for both road and intermodal transport (road and railway network, intermodal terminals) should be at least partly provided by the government, only the amortisation costs for rolling stock are included in the analysis. Thus, the analysis considers only specific costs depending on time, distance and transport units.

The following section defines the cost elements of the intermodal and the road transport alternatives.

5.2.2.1 Intermodal transport

- Main haulage by rail:
  - Amortization of rolling stock: the amortization expense consists of depreciation on locomotive and wagons (1 train) plus interest on capital.
  - Maintenance of rolling stock: maintenance costs cover the expenses for regular maintenance and repair.
  - Energy: the energy costs cover the traction energy consumed during the process of main haulage. The scenarios are calculated with modern electric multi-current locomotives. Additional energy needed in the terminals (e.g. shunting, transshipment etc.) is not included in this element but covered by the terminal handling charges (see “Transshipment”).
Infrastructure access fees have been introduced in the EU due to the liberalisation of the rail infrastructure. Access fees have not been fully introduced in the most Eastern of the new member countries, and not at all in the candidate countries. In these cases, where the national rail companies remain in control of each train running on its network, specific contracts are needed to operate trains and therefore it is not always possible to obtain precise values for this cost element. Access fee information could be obtained for Germany, Czech Republic and Poland.

Drivers personnel (see below)

Organisation/disposition: this element contains the general costs for the organisation, administration and disposition of the door-to-door transport process. Since they are a combination of investment costs for information/data handling systems and personnel costs, a value can only be estimated in terms of a percentage of the overall costs.

Other: this element is intended to quantify the costs not listed explicitly in the data sources used for this analysis. For example, in most data sources, costs for taxes, licenses, and insurance are not listed separately.

- Transshipment: this element contains the cost for the terminal handling process from vehicle to vehicle (truck to train or vice versa). A distinction can be made between a direct transshipment between two vehicles and a consignment that includes temporary consignment storage within the terminal because the latter requires an additional movement. In this analysis it is assumed that an intermediate storage is always required, which is generally the case.

- Pre and post haulage: the costs for the road portions of the intermodal transport chain were evaluated based on short distance truck trips between the terminals and clients with the same road transport cost assumptions as for the road-only transport alternative (outlined below). In order to calculate a cost per TEU, the different road-cost elements are calculated for one day of service. Then the daily number of TEUs carried by one truck permits to derive the pre and post haulage cost per TEU.

5.2.2.2 Road transport

- Drivers personnel (see below)

- Amortization of the truck

- The prices for new trucks and the accrual rates differ between the EU countries, especially the new member states. The cost analysis is based on the assumption that carriers purchase new trucks rather than lower priced used trucks. This assumption may not be totally valid in the case of Eastern countries.

- Tax/licenses

- Tax/licenses are included in the “Insurance” element due to the structure of the data available.

- Insurance

- Insurance may have to be taken out for various objects including the truck itself and its cargo. The obligatory minimum insurance varies from one country to another, and the transport of special (e.g. hazardous) freight requires additional insurance.

- Road toll
Most countries charge trucks a fee for using motorways. This charge can be levied in different ways: Poland, the Czech Republic and Hungary use a vignette system based on unlimited road use for a certain period of time, while Germany and Austria have established distance-based systems where the charges are calculated from a fixed price per kilometre. In addition to these systems additional tolls are levied for the use of special infrastructure sections, such as tunnels or segments operated by private concessionaires.

- **Fuel**
  - The fuel prices are gross prices (VAT not included) from September 2005.

- **Tyres**
- **Maintenance and repair**
  - If the maintenance is outsourced, the costs for the garage must be considered, if not, those are replaced by costs for the own garage personnel and for the material (replacements etc.) including its storage.

- **Organisation/disposition (see “Other”)**
- **Other**
  - In addition to other costs not mentioned explicitly, this element includes the cost for organisation and disposition of trucks and drivers. Although there is a dedicated element in the intermodal calculation, the available data for road transport did not allow quantifying the costs for organisation and disposition as an own cost element of the calculation.

### 5.2.2.3 Driver Costs

The costs for drivers in the road transport sector consist of different components as those in the intermodal transport sector.

First a railway locomotive operator’s work day is structured differently from a truck driver’s work day. One long distance (international) train is often driven by several different operators from origin to final destination, because one operator’s experience and knowledge is limited to a certain segment of the rail network.

Instead, locomotive operators conduct several trains over a certain distance with considerable time intervals in between trains. In contrast, a truck driver is generally responsible for his “own” (literally or not) truck during the whole day. Thus, the driving time factor (i.e. the proportion of actual driving time to total labour time) for a locomotive operator will never be as high as for a truck driver. The factor is estimated to 0.6 for the railway and 1.0 for the road sector.

Second, a truck driver is more flexible concerning labour time on long distance routes, because he can decide how far to go on a single day as long as he respects the general limit of 10 hours per day plus breaks. Furthermore, generally speaking, the ancillary wage costs are higher in the railway than in the road transport sector due to the strength of railway unions. The margin is considerably greater in the Eastern countries than in the EU 15, because railway personnel are often (still) government employees rather than employees of private operators like truck drivers.
5.2.2.4 Cost Element Overview

Table 5.2 summarizes the cost element assumptions used in the scenarios.

In this analysis the fixed costs per year were calculated in terms of the truck’s average operational performance (given in km/a). For example, the amortisation cost element was calculated dividing the truck price, multiplied by the amortisation rate, by the average distance driven per year. This was necessary to be able to better compare the single cost elements with each other.

Not shown in Table 5.2 are charges for infrastructure and the road tolls. These cost elements respectively have been calculated separately for each example route, because in most cases the price depends on more than simply distance. For details see annex 4.2.
### Table 5.2: Cost element assumptions for the status quo analysis

To get an idea of the reliability of the data sources the possible deviations of the assumed values (depending on the data source) have been analysed. The following figures show the most significant cost elements of each transport mode with their assumed value and assumed minimum and maximum values. The margin between minimum and maximum describes the range of realistically possible values of each element.

---

14 Resp. truck + trailer for swap bodies; the calculation bases on the tractor trailer

15 2 lifts per terminal
The sensitivity analysis shows that the operational performance and the used truck/train capacity cost elements show the greatest range for both transport modes. In other words, their assumed values in the different scenarios are likely to vary more than values for the other cost elements.
The used truck capacity is a special case, because the only possible values are the minimum and maximum values. A truck with a total capacity of 2 TEU can load either zero, one or two TEU (representing 0%, 50% or 100% of the overall capacity); no other values are possible. So dividing the used capacity by 2 means doubling the total cost per TEU. None of the other cost elements show a margin greater than 50 €/TEU between minimum and maximum values.

### 5.2.3 Status Quo Cost Analysis

#### 5.2.3.1 Road Transport

Table 5.3 presents results of the cost calculation for road-only transport including for all eight scenarios described above.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>1 full load per truck</th>
<th>2 half loads per truck</th>
<th>Full load from seaport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (km)</td>
<td>BPM - Prague</td>
<td>BPM - Krakow</td>
<td>BPM - Kiev</td>
</tr>
<tr>
<td>Driving time (h)</td>
<td>8.44</td>
<td>17.29</td>
<td>36.00</td>
</tr>
<tr>
<td>Fuel (€)</td>
<td>85.00</td>
<td>144.01</td>
<td>254.81</td>
</tr>
<tr>
<td>Annuity (€)</td>
<td>79.79</td>
<td>153.82</td>
<td>296.63</td>
</tr>
<tr>
<td>Tax/licenses/insurances (€)</td>
<td>5.48</td>
<td>10.94</td>
<td>20.42</td>
</tr>
<tr>
<td>Road toll (€)</td>
<td>47.09</td>
<td>94.18</td>
<td>188.35</td>
</tr>
<tr>
<td>Fuel (€)</td>
<td>155.46</td>
<td>293.72</td>
<td>504.93</td>
</tr>
<tr>
<td>Tyres (€)</td>
<td>26.40</td>
<td>52.80</td>
<td>98.15</td>
</tr>
<tr>
<td>Maintenance/repair (€)</td>
<td>21.12</td>
<td>40.24</td>
<td>76.52</td>
</tr>
<tr>
<td>Driver (€)</td>
<td>20.99</td>
<td>39.78</td>
<td>79.55</td>
</tr>
<tr>
<td>Total cost per truck (€)</td>
<td>427.33</td>
<td>778.61</td>
<td>1411.41</td>
</tr>
<tr>
<td>Cost per km (€)</td>
<td>0.81</td>
<td>0.77</td>
<td>0.72</td>
</tr>
<tr>
<td>Cost per TEU (€)</td>
<td>22.69</td>
<td>389.31</td>
<td>709.71</td>
</tr>
</tbody>
</table>

Table 5.3: Status quo analysis for road-only transport scenarios

As shown in Table 2, for these connections the largest cost element for road-only transport is fuel cost, which represents about 36% of the total cost per consignment. The driver cost only represents 15 – 20%, and the amortization 18 – 21% of the total costs.

It seems likely that the percentage for tax, licenses and insurance of just 1 – 1.5% of the total cost is slightly underestimated. A closer look at the data source\(^\text{17}\) shows a significant difference between the individual values of the taxes, licenses and insurance cost element in the countries evaluated for this study with the Czech Republic having an extremely low cost.

No explicit values could be obtained for disposition and organisation. The only source mentioning overhead as an individual cost element does not provide any values for most of the countries evaluated in this study [2].

In summary, results of the analysis show that the total cost for shipping a TEU by road-only transport is directly proportional to the distance, i.e. twice the distance almost doubles the cost per TEU, while the cost per kilometre stays more or less constant.

#### 5.2.3.2 Intermodal Transport

The three tables in this section present the results of the cost analysis for intermodal transport under current conditions (status quo). Table 5.4 presents costs for the continuous main haulage scenario. Table 5.5 presents costs for the main haulage with intermediate transshipment between two trains scenario. Table 5.6 presents costs for the post haulage only scenario (seaport).

---

\(^{16}\) For an operator it makes no difference whether an ITU is empty or not (the capacity is used anyway).

\(^{17}\) DHL data
Table 5.4: Status quo analysis for intermodal transport - Continuous main haulage scenario

Table 5.5: Status quo analysis for intermodal transport - Broken main haulage scenario

Table 5.4 and Table 5.5 clearly show the magnitude of pre and post haulage costs. They represent up to 37% of the overall cost per TEU although pre and post haulage covers a maximum of only 20% of the total distance travelled. This reflects one of the major disadvantages in intermodal transport: the considerable loss of time caused by the terminal handling processes along with an inefficient and expensive truck service network.

The difference in efficiency of pre and post haulage brought about through the use of smaller terminals with shorter pre and post haulage distances is considerable. As shown in Table 5.4, the cost for pre and post haulage on the Frankfurt/M – Prague route is 77% higher for the 50 km haulage (133.13 €/TEU) than for the 20 km haulage (75.09 €/TEU). This increases the total transport cost per TEU by 19%. The two main reasons for this cost increase are the longer travel distances, and the longer waiting time in larger terminals caused by inefficient internal organisational structure. One important point not shown in the tables is the difference in pre and post haulage costs in relation to the destination terminal's location. These costs vary significantly among the middle and Eastern European countries. The difference between Poland with the highest cost level (in pre and post haulage) of these three destination countries and the Ukraine is about 44%.

As expected, transshipment represents a significant cost in the intermodal transport process. The continuous haulage requires two transshipment operations (truck to train and train to truck) while the broken haulage requires three (it adds a train to train transshipment in the intermediate terminal), thus increasing total costs. For example, the transshipment cost represents up to 23% (for the 500 km distance) of the total transport costs in the continuous haulage scenario and up to 31% of total transport costs in the broken main haulage scenario.

The share of pre and post haulage costs and transshipment costs decreases as a proportion of total cost as the main haulage distance increases. For example, in the 2000 km route with...
continuous main haulage scenario, the transshipment costs drop to 13% of total costs, while the pre and post haulage costs reach a lower limit of 11% (in the 20 km scenario). While the share of pre and post haulage costs are substantially reduced under this scenario, they remain considerable especially since the pre and post haulage distance drops to only 2% of the total distance travelled.

As distance increases the costs for amortization and for use of the railway infrastructure become more important. For example in the 2000 km scenario amortization rises up to 15%, while infrastructure use rises up to 23%. A notable trend is that national railway companies in Eastern European countries tend to raise their infrastructure charges close to the level of Western Europe although the wage and material costs for maintenance and repair or upgrade are normally much lower.

Table 5.6 presents results of the cost analysis for the no pre haulage (seaport) scenario.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Main haulage from seaport</th>
<th>Post haulage ca. 50 km</th>
<th>Bremerhaven - Katowice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (km)</td>
<td>Rostock - Poznan</td>
<td>Bremerhaven - Katowice</td>
<td></td>
</tr>
<tr>
<td>479</td>
<td>1397</td>
<td>1782</td>
<td></td>
</tr>
<tr>
<td>Rolling stock</td>
<td>172</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>Annuity (€)</td>
<td>527</td>
<td>1121</td>
<td></td>
</tr>
<tr>
<td>Maintenance (€)</td>
<td>837</td>
<td>1782</td>
<td></td>
</tr>
<tr>
<td>Insurances (€)</td>
<td>172</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td>Energy (€)</td>
<td>904</td>
<td>1642</td>
<td></td>
</tr>
<tr>
<td>Infrastructure charges (€)</td>
<td>558</td>
<td>1077</td>
<td></td>
</tr>
<tr>
<td>Driver (€)</td>
<td>1800</td>
<td>1800</td>
<td></td>
</tr>
<tr>
<td>Organisation/disposition (€)</td>
<td>59.32</td>
<td>59.32</td>
<td></td>
</tr>
<tr>
<td>Other (€)</td>
<td>38</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>Total cost per train (€)</td>
<td>6233.81</td>
<td>10840.81</td>
<td></td>
</tr>
<tr>
<td>Train cost per km (€)</td>
<td>13.01</td>
<td>10.64</td>
<td></td>
</tr>
<tr>
<td>Train cost per TEU (€)</td>
<td>129.87</td>
<td>225.85</td>
<td></td>
</tr>
<tr>
<td>Transhipment per TEU(€)</td>
<td>70.00</td>
<td>70.00</td>
<td></td>
</tr>
<tr>
<td>Post haulage per TEU (€)</td>
<td>59.32</td>
<td>59.32</td>
<td></td>
</tr>
<tr>
<td>Total cost per TEU (€)</td>
<td>259.19</td>
<td>355.17</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.6: Status quo analysis for intermodal transport - Seaport scenario

Comparing the Bremerhaven – Katowice example from Table 5.6 to the Frankfurt- Krakow example (both routes are approximately 1000 km.) shows the reduction in cost when no pre haulage by truck is necessary. In this example, the cost for pre- and post-haulage is reduced from 140.01 to 59.32 €/TEU, a reduction of 58%; the reduction is greater than 50%, because the pre haulage would be done by a more expensive German carrier and the post haulage is done by a less expensive Polish carrier.

The infrastructure charges are also lower with no pre haulage. The reduction in pre haulage and infrastructure costs means that the total cost in the no pre haulage scenario (in the 1000 km example) is 24% lower than the corresponding example with pre haulage (Table 5.4); the total cost is 355 €/TEU compared to 466 €/TEU.

Finally, it should be noted that while transshipment costs in seaports are higher than in inland intermodal terminals, this does not affect the cost analysis because these additional costs must be included in both the intermodal and road transport examples.

5.2.3.3 Comparison between road and intermodal transport

Once the costs for the example scenarios for consignments by road-only and intermodal transport were calculated the costs for various scenarios were plotted on a cost (per TEU) versus distance graph. These graphs help provide a better understanding of the influence of the factors on intermodal transport’s competitiveness with road-only transport.

Figure 5.8 compares the cost per TEU for road transport (truck full load) with intermodal transport (continuous main haulage between two large terminals with 50 km pre and post haulage distance).
Figure 5.8: Break-even analysis - Status quo

Figure 5.8 clearly illustrates the main difference between intermodal and road-only transport; intermodal transport has high fixed costs while road-only has high variable costs. Thus, as shown in the figure, over short distances the cost per TEU moved is higher for intermodal transport, and over longer distances the cost is higher for road-only transport. The figure shows that road-only costs rise faster than intermodal costs (the blue curve has a steeper gradient than the green one) and that transport costs are equal for both modes at about 1400 km. These results agree with actual conditions in central and Eastern Europe in that intermodal transport is far from being a serious competitor to road-only transport at distances less than 1000 km. Even on long distance routes of 1000 km intermodal transport is almost 20% more expensive than the truck in road-only transport.

Figure 5.9 illustrates the impact of pre and post haulage on intermodal transport costs. In Figure 5.9 the green line represents the cost per TEU for intermodal transport with 20 km pre and post haulage distance, the red dashed line represents the 50 km pre and post haulage case (from Figure 5.8), while the brown dash-dotted line represents the 70 km pre and post haulage case. The blue line representing the road transport cost is unchanged from Figure 5.8.
Figure 5.9: Influence of pre and post haulage distance

Figure 5.9 makes clear the importance of an optimised terminal location. Reducing the average distance between intermodal terminal and the consignor/consignee by 30 km reduces the break-even point between road-only and intermodal transport by 293 km (or 21%) to approximately 1100 km. Taking 70 km as the reference distance, the difference to the 20 km distance is 466 km (or 30%).

Another important point to keep in mind is that pre and post haulage distances are not distributed evenly. If the terminal is situated inside an important commercial area with several clients in the direct neighbourhood, a large share of pre and post haulage relations can be shorter than the average distance. Thus it is possible to have routes with single clients based relatively far from the terminal without significantly increasing pre and post haulage costs. Pre and post haulage costs for intermodal transport can be significantly reduced by using intelligent tour management techniques to serve multiple clients with one truck.

Figure 5.10 illustrates the impact of a broken main haulage (i.e. transshipment in an intermediate intermodal terminal) on costs. The yellow line on Figure 5.10 represents the costs per TEU when transshipment is necessary; all the other lines are the same as in Figure 5.9.
Figure 5.10: Influence of broken main haulage processes in combination with short pre and post haulage distances

As shown in Figure 5.10, the costs added by transshipment moves the break-even point between road-only and intermodal transport to approximately 1270 km. This scenario includes the 20 km pre and post haulage distances.

Figure 5.11 illustrates the cost per TEU compared to transport distance for the no pre haulage (seaport) scenario.

Figure 5.11: Break-even analysis - Seaport scenario
As shown in Figure 5.11, under the same assumptions for road-only and intermodal transport used to create Figure 5.8, the break-even point shifts significantly when the costs for pre-haulage are eliminated. The break-even point moves below 1000 km to 850 km. While the road-only transport curve remains more or less at the same level as in Figure 5.8, the intermodal transport curve comes down to a level between 300 and 400 €/TEU. At a distance of 1000 km the truck cost per TEU is at 107% of the railway.

It becomes evident that the potential for intermodal transport is much higher in transport situations, which do not require a pre- or post-haulage (such as seaport-hinterland transport) than in situations that require pre and post haulage. Figure 5.11 shows that by eliminating pre-haulage intermodal transport is a good alternative to road-only transport even on medium distance trips.

Seaports are especially attractive for intermodal transport because, in addition to eliminating the need for pre-haulage, it is much more likely to fill a train to capacity given the greater commodity flows passing through a typical seaport.

### 5.2.4 Sensitivity Analysis

Once the status quo analysis was completed a sensitivity analysis was performed to test the impact of changes to three selected variables (fuel prices, wage costs, and road tolls) on the competitiveness of intermodal transport. Two scenarios were tested: a “Trend Scenario” which assumed that existing trends with respect to these variables would continue and a “Maximum Scenario” which assumed that these trends would accelerate.

Under the “Trend Scenario” the following three changes were assumed:

1. Fuel prices increase by 50%;
2. Wage costs for road transport in the CEEC increase by 50%;
3. An EU-wide standard toll of 0,125 €/km. is implemented.

These three changes were included in the Trend Scenario because they appear plausible under current conditions. Fuel prices are likely to increase. The current price of oil (approximately 60 US$ a barrel) is almost 50% higher than in 2004 – and this does not even reflect the price volatility shown in summer 2005 and during the hurricane season when oil prices rose to over 70 US$ per barrel. Most experts agree that oil prices will not decrease in the coming years.

Wage costs in the Central and Eastern European Countries are also likely to increase in the coming years. Wages in the CEEC have been stable for years, but rapid economic growth in these countries is expected to increase inflation rates creating upward pressure on wages.

Finally, it is likely that road toll systems will be implemented in the EU in the coming years. The urgent need to improve transportation infrastructure combined with increasing budget deficits in several countries is forcing governments to look for alternative means of financing. Whether PPP models or other solutions are adopted, in any case policy makers are slowly moving towards the consensus that charges on the use of infrastructure are sensible microeconomic policy not only in the railway sector but also on the road sector. It may be discussed whether Brussels will set a standard toll and technology or allow national governments to decide on the toll rates and technical systems. In any case the toll rate of 0,125 €/km seems to be a realistic starting rate. It reflects more or less the actual German standard, which is not the upper limit, compared to other EU countries.

The “maximum scenario” reflects the upper bound of how general conditions might change to favour intermodal transport within the next 10 to 15 years. Under the maximum scenario the following five changes were assumed:

1. Fuel prices increase by 100%;
2. Wage costs for road transport in the CEEC increase by 100%;
3. An EU-wide standard toll of 0.15 €/km is implemented;
4. Average speed on motorways decreases by 20%;
5. Operational performance in road transport decreases by 20% due to the lower average speed.

Points 1 to 3 are based on the assumptions of the “trend scenario” and reflect a possibly more rapid development of these trends.

The decrease in average motorway speed may be caused by an increasing congestion on the road network, especially in the EU 15 countries, because at a certain level of traffic, the existing infrastructure will not be able to handle any additional demand, and further capacity upgrades will be extremely difficult in many larger regions. Furthermore it is unlikely that infrastructure improvements in the CEEC countries will be able to keep up with the rapidly growing road transport demand – especially since there remains a significant backlog of improvements necessary in these countries.

Finally, in addition to the specific variables that were changed in the two sensitivity analyses, the costs of the other elements (i.e. those that were not specifically changed such as the wage cost) were adjusted upward to account for the impact of fuel price inflation. The fuel prices’ impact on the other cost elements has been set to 5% for the trend scenario and 10% for the maximum scenario for all costs except electricity. The costs for electric energy were increased by 25% in the trend scenario and 50% in the maximum scenario, since the production of electric energy (or at least a considerable part of it) depends directly on mineral oil.

Figure 5.12 compares the road-only and intermodal transport costs versus distance under the maximum scenario (in green), the trend scenario (in yellow), and the status quo scenario – assuming continuous main haul and 50 km pre and post haulage for the intermodal alternative – (in red).

Figure 5.12: Prognosis with pre and post haulage distance 50 km
As shown in Figure 5.12, the two sensitivity analysis scenarios show a significant decrease of the break-even distance. The break-even distance shifts from 1380 km in the status quo...
scenario to 898 km in the trend scenario (a reduction of 35%) and to 640 km under the maximum scenario (a reduction of 54%).

Figure 5.13 compares the trend scenario and maximum scenario to the status quo scenario assuming continuous main hauls with a 20 km pre and post haul distance for the intermodal transport alternative.

![Prognosis - Cost per TEU (incl. inflation) pre/post haulage 20 km](image)

**Figure 5.13: Prognosis with pre and post haulage distance 20 km**

The original break even point under the status quo alternatives was 1087 km, under the trend scenario this would be reduced to 648 km (40%), while under the maximum scenario it would be reduced to 439 km (60%). Under these scenarios the break-even point is reduced to a value which makes intermodal transport competitive even on medium distance routes such as Frankfurt/M – Prague (500 km). On the Frankfurt/M – Krakow route (over 1000 km) road-only transport would be 25% (under the trend scenario) and up to 54% (under the maximum scenario) more expensive than intermodal transport.

Figure 5.14 compares the trend scenario and maximum scenario to the status quo scenario assuming no pre haulage (seaport scenario).
Figure 5.14: Prognosis with seaport scenario

As shown in Figure 5.14, the break even point in the seaport scenario is reduced from 850 km in the status quo scenario to 571 km in the trend scenario, and to 386 km. in the maximum scenario. The shift in break-even point (in other words the gain in competitiveness) in the seaport hinterland transport is less important than in the previous two cases, because by eliminating the pre haulage in the status quo alternative the intermodal alternative is already fairly competitive.

Figure 5.15 summarizes the impact of all variations of the status quo scenario and their behaviour under the impact of the two sensitivity analysis scenarios. For each variant it shows the break-even point in the status quo scenario, the trend and the maximum scenario.

Figure 5.15: Sensitivity analysis for the different development scenarios
As shown in Figure 5.15, the trend and the maximum scenarios have a similar impact on the status quo variants reducing the break-even distance. In all cases except the seaport scenario variant this reduction is on the order of 650 – 700 km in the maximum scenario. The margin is slightly higher for the variant with broken main haulage and two half loads per truck. This may be because in that case the truck has to run an additional 100 km to serve the two different clients, which has significant consequences on the costs given elevated fuel prices and wage costs.

5.2.5 Conclusion

The analysis results (presented in the previous paragraphs) show that within the next 10 – 15 years intermodal transport has a good chance to become competitive on medium distance routes of 500 – 700 km. This means that on routes with high demand (e.g. Southern Germany – Slovakia/Western Hungary in the automotive sector) intermodal transport may be expected to show significant gains in market share.

However, it should be emphasized that this cost analysis has neglected the qualitative aspect of transport services. One reason is that quality criteria are difficult to integrate into the proper cost analysis; the other is the poor availability of data. When considering the results of this cost analysis it is important to remember that today, in most cases, intermodal transport cannot meet the clients’ quality requirements such as supply chains with just-in-time management. Several problems in the intermodal transport chain cause delays and prevent the operators from keeping the expected time window of delivery.

More specifically, if the intermodal transport cannot cope with the client’s quality requirements, it will never be a competitive alternative even if the price is lower than for road transport.

Since the future scenarios evaluated in this analysis considered changes to variables that are not under the control of private transport operators (e.g. fuel prices, tolls), it will be up to the EU and national authorities to make the right decisions to increase the competitiveness of intermodal transport on long and medium distance routes.

Nevertheless the intermodal transport operators themselves will have to make their contribution to increasing competitiveness by optimising the intermodal transport chain. This implies the creation of a proper network of terminals with terminal locations designed to minimise the average pre and post haulage distance while assuring a minimal operational performance. Finally, the organisation of the intermodal transport chain with its different operators participating in the process has to be optimised. Strategies for this are developed in chapter 5 of this report.

5.3 Environmental aspects in intermodal transport

Transportation is widely recognized as having a major impact on the environment. Public policy around the world is attempting to improve the sustainability of transportation systems and reduce the sector’s environmental impacts. The aim of the Kyoto Protocol (an amendment to the United Nations Framework Convention on Climate Change (UNFCCC)), as a widely accepted document in environmental policy, is to reduce the ratifying countries’ emissions of carbon dioxide and five other greenhouse gases. Furthermore the international ISO standard on environmental management systems (DIN EN ISO 14001) exists since 1996. As part of a group of norms the DIN EN ISO 14001 specifies requirements for an environmental management system to enable an organization to develop and implement a policy and

18 “Sustainability”, according to the “Brundtland Report” from 1987, seeks to “meet the needs of the present without compromising the ability of future generations to meet their own needs.”
objectives, which take into account legal requirements and information about significant environmental aspects. The focus lies on a continuous improvement process in order to achieve the environmental goals of an organization (companies, public institutions etc.) and to develop general environmental awareness. Each organization is asked to implement an environmental policy with goals, implementation strategies and an appropriate management system.

While the environmental impacts of transport are widely considered on the policy level they seem less important on the operational level in the freight transportation business. Today consignors choose their transport mode almost exclusively based on cost and quality. Therefore freight forwarders and their subcontractors choose the appropriate transport mode themselves to meet their clients’ price and quality requirements. Thus no difference is made between rail (in most cases the environmentally favourable alternative) and road transport; the “product” sold to the consignor is the same.

In the future the importance of environmental considerations is expected to grow permanently. A trend is visible that certain consignors show an increasing environmentally sensitive behaviour and prefer to choose themselves the appropriate transport mode for their consignments, i.e. in some cases they prefer intermodal transport rather than road transport even if the price is not the same. The reason for this may for example be the consignor’s internal environmental policy or an increasing general environmental awareness. Analysts see the margin the consignor might be willing to pay for environmentally friendly freight transportation in the range of about 1-5% above normal prices; under certain conditions they believe that even a 10% increase may be realistic. These margins may grow further with the consignors’ increasing awareness of the environmental impact caused by the transportation sector.

The reaction on the forwarders’ side (not only driven by European and national legislation) has to be a general awareness of the consignors’ concern on environmental aspects. Appropriate logistical solutions have to be offered and to be marketed accordingly. Yet certain offers exist to sell the consignor certain add-ons for providing special low emission road transport solutions. Such offers may for example guarantee that a particular consignment will be carried exclusively by vehicles powered by natural gas. Currently the use of rail haulage as an alternative transport mode is (in most cases) not included in any of these programs because of the insufficient development of information systems.

Another example of considering environmental impacts is the certification of transportation providers. For example, Sweden has introduced a certification for environmentally friendly transport (as part of the “Good Environmental Choice” program). Freight carriers (e.g. the railway operator “Green Cargo”) certified by this program, may promote their services as meeting the criteria of the Swedish Society for Nature Conservation (www.snf.se). In order to be certified freight carriers need to go through an environmental analysis to determine whether the transport solution complies with the requirements. This certification program is intended to encourage freight consignors to put more weight on the environmental aspect during their selection of a specific transport mode.

Since considering the environmental impacts of freight transportation is a relatively new subject there are no profound experiences available to report at this time. A certain general awareness of the matter is no doubt necessary to establish it as a core aspect of the transport business. But it is important to note that certain sectors (e.g. the electronics, but also the oil and mining industry) already attach more importance to the environmental aspect. Therefore it can be expected that in the near future environmentally friendly transportation will have a considerable impact on the decision making process for all consignors and thus on the modal split in freight transport in general.
6 Resulting Strategies

The objective of this chapter is to outline in a first section a number of actual problems in intermodal transport and to derive in a second section a number of business, market and operational strategies to eliminate or to avoid these problems.

6.1 Major Problems in Intermodal Transport

6.1.1 General Remarks

The problems with intermodal transportation can be described in two ways: from the consignor’s viewpoint and from the transport provider’s viewpoint.

From the consignor’s viewpoint intermodal transport is simply non-competitive with road-only transport on many potential routes (relationships). More specifically, in most potential markets:

- Intermodal transport is more expensive than road transport;
- Intermodal transport takes longer than road transport;
- Intermodal transport is less reliable than road transport;
- Intermodal transport’s offer (routes, frequency) is often insufficient to meet the consignors’ needs.

From the transport providers’ perspective today the market for intermodal transport is small, although with a high growth potential. The actual situation of a diversified market with many operators makes it very difficult to build up an attractive and efficient transport network. It is especially difficult to develop a network between the EU 15 countries and the CEEC, because the cost of road transport in the latter is much lower compared to the EU 15.

The problems can be divided into two main groups:

- Quality (i.e. reliability, speed etc.);
- Coverage area (i.e. network density/number of routes offered).

In both groups the effects are higher production costs and a reduced competitive position compared with road transport.

In the following the groups are analysed in detail including a discussion of possible solutions.

6.1.2 Quality

6.1.2.1 Overview

When choosing an appropriate transport mode for a consignment, cost is not the only criteria to consider. In contrary, the quality aspect has normally much more weight in the decision making process. In other words consignors, who experience poor quality will not be willing to use intermodal transport even if it is competitive in terms of costs. In such cases the cost criteria is of no importance. Therefore, quality problems have to be addressed with highest priority.

The main quality problems and their consequences on the transport chain are listed in Table 6.1.
<table>
<thead>
<tr>
<th>Problem</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too many independent partners in the transport chain (number of external interfaces)</td>
<td>Independent partners do not share the same business interests. High costs caused by inefficiencies at interfaces between independent partners. Unclear responsibilities towards the customer.</td>
</tr>
<tr>
<td>Unclear responsibilities towards the customer</td>
<td>Difficulty to solve quality problems.</td>
</tr>
<tr>
<td>Transport chain partners use different information systems</td>
<td>Inefficient information handling and loss of information at interfaces increase cost and quality problems.</td>
</tr>
<tr>
<td>Poor quality of the single transport processes (main haulage, pre/post haulage etc.)</td>
<td>Spare capacity needed to address delays (e.g. in terminals). Overall transport quality may be insufficient for the logistic requirements of consignors (e.g. just in time management).</td>
</tr>
</tbody>
</table>

Table 6.1: Quality problems and their consequences

6.1.2.2 Problems Related to Transport Chain Organisation

The intermodal transport chain is composed of several elements and an equivalent number of interfaces between them, as illustrated in Figure 6.1:

![Intermodal Transport Chain Diagram](image)

Figure 6.1: Intermodal Transport Chain

The item “Intermodal Box” is not subject of this project.
The central column represents the chain of physical transport processes from a consignor to a consignee: During the pre haulage process the consignment (any kind of ITU) is collected at the consignor’s address (normally by truck) and transported to a nearby intermodal terminal. Several ITUs are collected in the terminal and afterwards transhipped (sometimes directly without storage) onto a train. The main haulage process describes the rail transport from the origin to the destination terminal. Depending on the structure of the main haulage network, i.e. if there is no direct train connection on the demanded route, some ITUs have to be transhipped between two trains in a hub. From the arrival in the destination terminal on the process described above is inverted (i.e. terminal transshipment and post haulage to the consignee’s address).

Parallel to the physical transport chain ancillary processes (especially information management) are necessary to successfully organise, link and control the single processes in terms of time/cost efficiency and quality.

Between each process interfaces have to be defined to transmit the physical consignment as well as the necessary information related to the consignment. Between the transport processes each interface stands for a physical transshipment of the ITU. The parallel virtual interfaces for information exchange are more difficult to define, because there are several possibilities to organise them (e.g. mail, telephone, IT systems etc.). They are used to transmit the necessary information between two transport processes more or less simultaneously to the physical transport process.

Note that the element “Intermodal Box” is not critical in the context of this analysis. Normally consignors hire a box from a box owner for one or several transports. In Europe, ITUs for land transport generally are owned by forwarding companies and by ship owners for sea transport. Owners which are companies with a European or worldwide network can minimize the transport of empty boxes by carefully planning their reuse.

The greater the number of independent partners involved the more complex the intermodal transport becomes. Since each company tends to optimize its “own” process independently (with the objective of maximal benefit), it is difficult or impossible to optimize the entire transport chain. Similarly, also the costs and organizational problems associated with the interfaces increase in multi-partner transport chains thereby increasing costs and reducing service quality for the whole transport chain.

If a single partner operates several elements of the transport chain, there are fewer external interfaces. External interfaces are interfaces between two independent partners. They are more problematic compared with internal interfaces (between two processes managed by one same partner), because today the information systems in intermodal transport are not standardised.

The management of information flows between partners is a huge problem. Every partner in the intermodal transportation chain has its own particular information system. Often information transfer is refused, because partners do not want to share internal information with other partners, even if is often technically possible. Therefore all necessary information must be re-entered into the (next partner’s) information system at the interface, which takes time, increases costs, and increases the likelihood that mistakes are made. The result is a badly synchronized information transfer or even a loss of important information at the interfaces.

It would be especially helpful for the terminal management process, if terminal operators could receive the necessary information electronically directly from the consignor (or the pre-

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20 More precisely, one physical interface can either be a vertical lift (by crane or reach stacker), in case the ITU is transhipped directly from the pre haulage vehicle onto the train wagon (or vice versa), or a complete transshipment between train/truck and the terminal storage area.
haulage truck driver) when the consignment is picked-up, rather than receiving the data only when it first enters the terminal. Likewise the trains can be tracked and the information passed on to the destination terminal right in advance before the arrival of the train.

Unclear responsibilities towards the customer and between the partners are dangerous, because the reliability and quality standards required cannot be guaranteed. The customer needs one contractual partner who is responsible for the whole transport chain (one face to the customer). Otherwise one partner of the transport chain would blame the other for bad quality, so that the customer would have no insurance for a certain minimum level of quality. Also the responsibility must be clearly defined between partners to prevent one partner from blaming the other for his own quality problems.

To solve (or at least reduce) these problems we need a:

- **Reduced number of independent partners** in the transport chain;
- **Clearly hierarchical organization** of the transport chain;
- **Uniform information interface**.

From this viewpoint only one partner managing the whole transport chain would be ideal, but this is practically impossible (at least on an international level). Therefore a minimum number of partners has to be organized in a hierarchical order to clearly define the responsibilities between each of them.

Since IT-based information management systems are widely in use today, a uniform interface for data exchange should be defined and implemented. This will help to avoid any loss of important information and to realise a highly efficient real-time data management system for the entire transport chain.

6.1.2.3 **Problems in the Main Haulage Process**

The quality of the main haulage process is defined as the reliability of the planned timetable, the frequency of service, and the speed, to name three of the most important aspects. These criteria do not exclusively depend on the railway (main haulage) operator. Two problems not directly under the control of operators are infrastructure capacity and the priority regulation for trains\(^{21}\). These capacity and priority problems can only be solved by **investments in railway infrastructure** and by the **influence of public authorities**.

The overall motivation for railway companies (and in some way for the infrastructure owners as well) is the market, in other words the possibility of making a profit. The result is that every company in the intermodal transport chain must have an interest in making sure that their business partners also make a profit. This is very difficult, if the partners in an intermodal transport service are competitors in another business (for example trucking companies which provide pre- and post-haulage as well as long distance road transport) or in another geographical field of intermodal transport\(^{22}\).

Problems caused by competition between railway companies (brought about by the EU’s policy of open access) can be solved, when a third party (intermodal provider or forwarder) orders the main haulage service.

*An example is HUPAC, which, as a terminal operator, orders the trains needed to connect its terminals.*

\(^{21}\) In Europe passenger trains have higher priority than freight trains, in contrast to North America.

\(^{22}\) Railway companies can be partners on one route and competitors on another.
Although quality requirements can be specified as part of the contract for main haulage services, the operators’ ability to fulfil these requirements is limited, especially when the quality problems are related to infrastructure capacity.

6.1.2.4 Problems in the Pre- and Post-Haulage Process

The cost of pre- and post-haulage (PPH) is currently very high compared to the main haulage. Therefore it is a key factor for the low competitiveness of intermodal transport. Based on today’s pre- and post-haulage costs, it is rather useless to offer intermodal transport for distances less than 500 km in Western Europe and less than 1000 km in Eastern Europe.

Table 6.2 uses the data from the cost calculation presented in section 5.2 to illustrate how improving the efficiency of PPH can significantly reduce costs for the entire intermodal transport chain. It presents the actual cost for PPH and the total transport as well as the percentage that PPH represents of total cost for a 20-km and a 50-km PPH case for a consignment from Germany to the Czech Republic (about 500 km).

Three assumptions regarding PPH efficiency are illustrated in the table: a 30%, 50%, and 70% use of the total capacity of a PPH truck during one shift. A 50% use of capacity assumes that there is a good coordination between terminal and PPH for minimising waiting time. The 30% column assumes no coordination, which can be the case when PPH is organised by a forwarder for only one or two consignors. The 70% capacity column assumes maximal use of PPH trucks during the whole day and an optimal organisation with waiting times of 10-15 minutes at terminal and consignor side. The costs of PPH shown in Table 6.2 should be considered estimates.

<table>
<thead>
<tr>
<th>Productivity</th>
<th>20 km pre- and post-haulage distance</th>
<th>50 km pre- and post-haulage distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30% use of capacity</td>
<td>70% use of capacity</td>
</tr>
<tr>
<td>PPH/TEU</td>
<td>116 €</td>
<td>75 €</td>
</tr>
<tr>
<td>Total Costs</td>
<td>344 €</td>
<td>304 €</td>
</tr>
<tr>
<td>PPH share of total costs</td>
<td>34%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Table 6.2: Cost of Pre- and Post- Haulage as a percentage of total costs under various PPH efficiency scenarios. Source: IVT

The numbers show the great influence of PPH efficiency on total costs and thus its importance on the competitiveness of intermodal transport.

Table 6.2 also illustrates the cost difference between a network with a few large terminals (which therefore has long PPH distances) and a network with a large number of smaller terminals. Comparing the cost of PPH for 20-km and 50-km PPH shows that the difference is between 50 and 100 € per TEU. This difference justifies the operation of smaller terminals with higher transshipment costs, even if such a network structure requires hubs and thus additional transshipments.

In practice, today in Western Europe, levels of utilization assumed in Table 6.2 (50% of total truck capacity used) are not always attained since the pre- and post-haulage is organized by consignors, or their forwarders respectively, exclusively for their own consignments. Therefore many trucks arrive at terminals with no coordination, resulting in long waiting periods especially in the early morning and late afternoon periods.
The pre-and post-haulage process is a key factor affecting the competitive advantage of intermodal transport in relation to the pure truck haulage.

Since the distance in PPH is only a small share of the total transportation distance (in some cases it is even opposite the main transportation direction), the costs per ITU can only be affected by having drivers transport as many ITU as possible during the working day. This requires, first, minimizing the waiting periods at the consignor and at the terminal, second, reducing the distance between terminals and consignors as much as possible, and third, optimising the route planning.

In conclusion, by improving the efficiency of the pre- and post-haulage process, the pre and post-haulage costs can be reduced enough to considerably improve the competitiveness of intermodal transport.

A suitable strategy would be to let the terminal operators manage and control the pre- and post-haulage process. This does not mean that they must own their own trucks; it is also possible that external pre and post-haulage operators can be employed as contractors by the terminal operator.

6.1.2.5 Solution of Quality Problems (Summary)

Table 6.3 summarises the quality problems in intermodal transport described above together with possible solution strategies:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too many independent partners in the transport chain (number of external interfaces)</td>
<td>Minimising the number of partners involved in the transport chain</td>
</tr>
<tr>
<td>Unclear responsibilities towards the customer (and between partners)</td>
<td>Hierarchical organisation structure in the transport chain (one face to the customer)</td>
</tr>
<tr>
<td>Inefficient information handling and loss of information at interfaces</td>
<td>Uniform information interfaces</td>
</tr>
<tr>
<td>Poor main haulage quality</td>
<td>Infrastructure capacity upgrade and better use of available capacity</td>
</tr>
<tr>
<td>Low efficiency in pre-and post-haulage</td>
<td>Better coordination with terminal processes</td>
</tr>
</tbody>
</table>

Table 6.3: Quality problems and possible solutions

6.1.3 Network Building

Apart from quality the other main problem is the area coverage of intermodal transport services, i.e. the density of the network and the number of direct connections available. In several cases the existing offer cannot satisfy the customers’ demand. Either a certain connection is not offered at all, or the transport time is much longer than by road due to the network structure making it unacceptable for the customers’ needs. This problem can be addressed by creating new and/or denser intermodal networks.

So far intermodal providers and railway operators built up connections between their own terminals or networks. However, the customers’ demand exceeds the offer of isolated networks:

- Consignors and forwarders are interested in a greater number of intermodal connections offered by several providers to enforce concurrence on the market leading to lower prices and better quality.
- EU-transport policy is intended to encourage optimal use of rail infrastructure and to expand the network of intermodal connections.
Therefore the next step consist in building up larger networks between different terminal operators, which requires different operators and intermodal providers to cooperate by handling consignments from external partners.

Often terminal operators today are only willing to handle ITUs from external partners if they have free capacity. For them they are not willing to invest in additional capacity (staff, cranes etc.), which is a significant detriment to network building.

6.1.3.1 Terminal Infrastructure

Terminals are the key part of the intermodal freight transport network. They are a prerequisite for the network, since they are the means for reaching the consignors (via pre- and post-haulage). Also new train connections are created only if terminals are in service.

Terminal investments are high, which implies great risk in connection with an uncertain development of demand. Therefore private companies are normally not willing to build terminals on their own risk (or at least not alone). In Western Europe, the governments often provide funding for terminals. In Eastern Europe terminal investments are normally made by railway operators, i.e. at least indirectly by the government. Most terminals are currently not owned by the owners of the railway infrastructure network but by railway operators (sometimes as shareholders of terminal operators) or by their daughter companies.

In many European countries terminals are not financed as part of railway investment programs, but in separate programs for intermodal transport. They are not yet widely understood as part of the public infrastructure network. This is inconsistent since terminals perform the same interface function between transport modes as passenger railway stations.

Therefore terminal investment (like railway infrastructure in general) is primarily in the responsibility of public authorities. This does not mean that private investment is not possible, but governments willing to encourage intermodal transport in their transport policy must play an active role in planning, financing and coordinating the construction of new terminal. On the European level, terminals are (or should be) part of the TEN program.

The role of the transport chain providers on terminal planning and investment is to push planning and investment decisions with market arguments. In Eastern Europe a strong lobbying effort by providers will be important in the next few years. When governments are not willing to support development of intermodal terminals, they cannot argue that they have an intermodal transport friendly policy.

Furthermore it is clear that terminals must be part of the public infrastructure. This implies a guaranteed free access to terminals (like free access to rail infrastructure) as a basic condition for network building and extension. It is a task for EU (and national) legislation to create an appropriate legal framework.

The location and number of terminals define the geographical coverage of the market. The choice of terminal location and their political support is very important for the further success of terminals. Terminal location with respect to the rail and road network as well as position in an industrial area has a great influence on rail transport costs and pre- and post-haulage distances and costs.

Therefore an international (public) coordination of terminal planning is recommended. A macroeconomic point of view is necessary to determine the optimal location for a terminal in terms of demand and efficiency, because private investors might put more weight on reaching certain clients of special importance to them. Therefore independent international organisations should be given the responsibility to determine or control the locations for new intermodal terminals.

Table 6.4 summarizes the main aspects and problems related to terminal planning and construction.
Table 6.4: Problems in terminal planning and their solutions

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk for terminal investments</td>
<td>Public financing of terminals (or at least support for private investors)</td>
</tr>
<tr>
<td>Open access to terminals not guaranteed</td>
<td>Adaptation of EU and national legislation</td>
</tr>
<tr>
<td>Bad coordination in terminal planning</td>
<td>EU and/or national coordination and control</td>
</tr>
</tbody>
</table>

6.1.3.2 Cooperation

The next step to build up larger networks between terminals by different operators requires different partners to cooperate by handling consignments from each other.

The basic preconditions for successful cooperation of two or more independent partners are:

- Similar business objectives;
- Prospects for success;
- Distribution of business risk in proportion to the forecast rewards (benefits).

In addition to these basic preconditions, it must be possible for the partners to clearly define responsibility for management and client care in the business process.

Clearly defining management and client responsibility means that one company must be designated as leading the effort and the other companies must be subordinated under that leader. One option, which works well for companies of equivalent size, is to create a management company to lead the effort, with shareholding in proportion of the business interests or with equal shares for all companies.

The precondition of sharing the same business objectives can be a problem, if one partner competes with another in some other part of the transport business. Three typical examples in the intermodal transport business are:

- Trucking companies that handle the pre- and post-haulage are partners of railway companies in intermodal transport business but they are competitors in the freight transport business. A trucking company may (but must not) prefer to transport an ITU over the entire distance rather than be a partner in intermodal transport.
- Railway operators can be integrated in intermodal transport chains as main haulage partners, but they can also work as competitors on other routes or in other freight businesses.
- Intermodal transport can compete with higher profit direct rail transport within the same railway company.

Therefore, to avoid this problem, the number of partners involved should be reduced to a necessary minimum and organized in a clear hierarchical structure (see chapter 6.1.2.2).

Operators in the intermodal transport chain often experience reliability problems with their partners. In such cases the quality problems of one partner (e.g. railway operator) increases costs for the other partners. Typical examples include:

- Terminals having to offer spare capacity because of delayed trains;
- Railway operators that cannot dispatch their trains on time because terminals have not finish loading.

This problem can be overcome by contract penalties. Contract penalties can be an effective way of assuring contracting partners’ reliability and quality, if responsibilities are clearly
defined in the whole transport chain. If one partner’s commitments are not clearly expressed in the contract, the ability to demand penalties in case of unreliability is low.

In most cases reliable prospects for long-term profit are unrealistic due to uncertain demand forecasts. If the expected demand is low because of today’s lacks in quality, the future service is likely to remain on a constant low level. Since intermodal transport requires large investments (e.g. in terminal infrastructure and rolling stock), high financial risks arise for the partners, if returns of investment cannot be guaranteed.

A possible solution is **sharing the investment risks between several partners and public authorities** (e.g. public-private partnerships for constructing and operating terminals or direct subsidies to private investments).

Table 6.5 summarizes the problems arising from the need for cooperation in intermodal transport together with possible solutions.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Similar business objectives necessary</td>
<td>Reducing the number of involved partners; Clear hierarchical structure</td>
</tr>
<tr>
<td>Unreliability of partners</td>
<td>Contract penalties</td>
</tr>
<tr>
<td>Uncertain demand forecasts</td>
<td>Investment risk sharing (infrastructure, rolling stock)</td>
</tr>
</tbody>
</table>

*Table 6.5: Cooperation problems and their solutions*

### 6.2 Business Strategies

#### 6.2.1 Strategies for the Single Partners

Each partner in the transport chain must develop specific strategies to increase the use of intermodal transport based on improving pre- and post-haulage and main haulage operations. This section outlines strategies for all the main partners. These strategies are organized in terms of the single partners involved in the intermodal transport chain (i.e. value adding companies) namely,

- Consignor;
- Forwarder;
- Pre- and post haulage operator;
- Main haulage operator (railway company);
- Terminal operator.

As outlined below, it is unlikely that either the consignor or forwarder could take direct responsibility for the process, but any of the latter three partners could logically transition into a supplier of integrated transport services. Strategies for each of these partners are outlined below.

**Consignor**

Consignors generally do not have a specific transport strategy. They are open for the use of any transport mode that meets their price and quality requirements. Consignors may, in the future, take an interest in specifying the use of intermodal transport for certain consignments in order to meet some type of environmental sustainability goal or objective, but this will only occur once intermodal transport companies are able to certify their environmental benefits either through a specific program or a general environmental labelling process.
Forwarder

Freight forwarders in the proper meaning of the word act as brokers and consultants between consignors and transport providers. As brokers they cannot offer their own transport services without having a conflict of interest and thereby losing their ability to choose objectively between competing transport companies. Therefore, forwarders cannot be expected to create intermodal transport providers; instead, they can become brokers between several different integrated transport providers thereby helping to encourage the development of these companies.

In case a forwarder plans to follow an expansion strategy by participating in the physical transport processes, the aim should be to build up a single operator transport chain (see section 6.2.2.2). Since this requires a strong position in the main haulage process, a financial participation in (or at least a tight cooperation with) an existing railway company is advantageous.

Furthermore a strong position in main haulage is essential also to effectively lobby Eastern European governments to have their intermodal transport infrastructure (rail network capacity and terminals) improved and thus to encourage a sustainable development of intermodal transport.

Main Haulage Operators (Railway Companies)

Due to EU regulations railway companies are the primary carriers and therefore unlikely to function as an integrated transport provider (i.e. from door-to-door). However, main haulage operators could help encourage the creation of integrated providers. They can own a part of the special wagons needed (similar to intermodal providers in Western Europe) thus helping to provide a reasonable diversification of risks for other partners. Open access does not encourage railways to provide special equipment such as railcar wagons for ITU. However, for locomotives as well as wagons it is more and more common to lease the needed equipment.

Other partners could also be more effective in helping Eastern Railroads provide better service quality. The current state of rail infrastructure and organization in Eastern Europe is poor, although European Union market rules and financial support for infrastructure construction gives hope for improvement. Many bottlenecks are being addressed and non-standard lines are being improved as part of planned and on-going investment programs. New rail freight companies are being organized especially in Poland and Slovakia. Rather than continuing to simply complain about poor service in the East, intermodal providers could have a greater positive impact by encouraging these improvements.

Terminal Operators = Intermodal Provider

The strategy that has been successful in the west is for the terminal operator to also act as an intermodal provider and thus at least to organise main haulage. This is also recommended in the CEEC. At the same time the terminal operator should also provide the pre- and post-haulage, either by subcontracting an external trucking company or with its own trucks and drivers (see below).

With this terminal operating strategy, external interfaces can be eliminated, the information flow can be simplified, and most importantly the expensive pre- and post-haulage trips can be organised more efficiently. In summary, the whole intermodal transportation system can be made less expensive.

Under this business model the interface between main haulage and terminal is also less problematic, because the management and operation of trains from terminal to terminal is done by contract between railway operator and terminal operator. With open access to railway infrastructure terminal operators can threaten to change the main haulage operator in order to improve quality.
Pre- and Post-Haulage Operator

A single operator must provide transportation between the consignor and terminal; this means that pre- and post-haulage is a logical business for the terminal operator to provide. Being responsible for pure haulage only, the pre- and post-haulage operator is subcontracted by or an immediate part of the terminal operator.

6.2.2 Business Strategies for the Entire Transport Chain

The intermodal transport chain, as it is organised today, does not match the strategies for solving the problems described in chapter 6.1, especially in terms of a clearly hierarchical structure. Therefore possible recommended models are outlined in this section.

6.2.2.1 Status Quo

Today the organisation of the transport chain is not geared to the actual transportation process, as illustrated in Figure 6.2. This organisational structure implies that the terminal processes would have to be aligned with the pre- and post-haulage (PPH) process, because the intermodal provider operating the terminal is a subcontractor of the forwarder who manages the PPH. The problem is that not just one operator does PPH for one terminal, but there are always several ones who have to be coordinated with the terminal processes. If the terminal operator has no influence on the PPH, he has no possibility to optimise his internal processes (see section 6.1.2.4).

Figure 6.2: Multi-partner operation Model - Status Quo (Source: IVT)

Apart from this problem, some positive development has already taken place. One partner managing several processes of the transport chain makes it easier to optimise the transport chain, thereby reducing costs and improving quality. Yet, this business model exists today, for example:

- HUPAC operates terminals and also manages the trains connecting its terminals by subcontracting external railway companies.
- DB as a railway operator is owner of the German terminal operator DUSS.
6.2.2.2 **Single Operator Transport Chain Strategy**

Given the cost, coordination, and quality problems identified with the existing intermodal transport chain, the optimal strategy would be for a single operator to manage the whole transport chain himself thus to provide seamless door-to-door freight transport services, as illustrated in Figure 6.3.

![Image of Operation model with main haulage operator as an intermodal provider](source: IVT)

The companies expected to have the greatest interest in such a strategy and the best chances for successful implementation are companies with the major part of added value in existing Western European intermodal transport chains, in other words, railway operators. This business model exists already in many Western European railway companies, especially with respect to traffic within a company’s own network (inland). Two good examples are:

- **SBB Cargo** operates its own intermodal product “Cargo Domino” which provides door-to-door freight service including: pre- and post-haulage, transshipment operations (direct transshipment from truck to rail wagon, no terminals necessary), main haulage, box leasing, and information services.

- **Rail Cargo Austria** owns its own terminals and trucks or works in cooperation with outside trucking companies.

On most international routes, where the main haulage must be provided by more than one railway operator, and/or the origin and destination terminals are not operated by a single company, the business model illustrated in Figure 6.3 is often difficult to realise. This is because the responsible intermodal provider has to contract with at least one other intermodal provider who operates the destination terminal.

If the principle of free access to terminals is not (yet) realised, such business relations cannot be established. Another reason could be the lack of a dominant partner (in other words no company stands to gain a significant benefit from working together to create a greater intermodal offer to the consignor).
6.2.2.3 Multi-Partner Transport Chain Strategy

This situation – the lack of a dominant partner – is exactly the case in most of the main East-West European axes (where railway operation and terminal operation is fragmented). These axes include state owned railway companies, and often these companies own the terminals or are shareholders of terminal owners. Other terminals completely outside of railway company influence also exist on these axes. Of the railway companies with a high added value interest in intermodal transport, few seem to be interested in offering international services or even a proper network.

One existing positive example in the East-West axes is the strong cooperation between Railion (Germany) and PKP (Poland). This cooperation extends to the Russian and Belarus railways as well.

Given these conditions it will be difficult for a single company to control the entire intermodal transport chain in the East-West transport market, and thus it is unlikely that the single operator strategy is feasible on these axes.

Therefore, the most realistic strategy to pursue so far is to minimise the problems of interfaces in the intermodal transport chain. This strategy consists of:

- Better coordinating the operation of terminals with pre- and post-haulage, and
- Having intermodal providers manage the main haulage services between terminals.

The first of these is a matter that can be directly addressed by various different partners in the transport chain. The second is already allowed as part of open access regulations throughout the EU and the candidate countries, which leaves terminal operators free to choose the best railway operator for main haulage services. Unfortunately open access is not possible in Russia, the Ukraine and Belarus due both to their wider rail gauge and current regulations. While regulations in these countries may be changed in the future, the gauge difference will still stand against it, and therefore other solutions are needed for optimal rail operation in these countries.

Figure 6.4: Operation model with forwarder and intermodal provider (source: IVT)
The proposed model illustrated in Figure 6.4 foresees an intermodal provider as a forwarder’s subcontractor. This intermodal provider operates the terminals and manages the main haulage service. The pre- and post-haulage is not operated by the forwarder any more but managed by the terminal operator. This structure allows the intermodal provider to directly control the entire transport chain from consignor to consignee. The responsibilities are clear between each of the partners so that the “one face to the customer” can be realised.

If the demanded connection is more complicated and exceeds one intermodal provider’s network, it is the forwarder’s role to organise a transport chain across several networks by subcontracting the intermodal providers whose networks are concerned.

Figure 6.5 illustrates a variant of the described model: an intermodal provider with a direct link to the consignor.

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**Figure 6.5: Operation model without forwarder (source: IVT)**

In this model no forwarder is needed, because the consignor himself chooses a suitable transport mode for a certain consignment and thus a partner specialised in this segment (intermodal provider) to organise the door-to-door transport for him. This is only possible if

- Origin and destination are within the provider’s own network, or
- The partner is cooperating with other intermodal providers operating a network in the origin/destination region.

Alternatively the consignor would have to subcontract two intermodal providers (i.e. unclear responsibilities) or let a forwarder do the coordination work for him (which is identical with the first model – see above).
6.3 Market Strategy

6.3.1 Results of the Market Analysis

This section presents conclusions of the market analysis based on the general assessment of market conditions for intermodal transport (chapter 4.3) and the detailed evaluation of market potential and costs (chapter 5).

First, there is a strong demand for freight transport on several corridors between Eastern and Western Europe. However, many of the products shipped (derived from the criteria described in chapter 5.1.3) are equally suitable for transport by truck as by intermodal (except chemical products). Therefore, with respect to goods categories, intermodal transport must meet the challenge of direct competition with road transport. It is clear that intermodal transport must carefully monitor the consignor’s price and quality requirements.

Most of the freight transported from East to West are semi finished goods and agricultural products. In the opposite direction most of the freight transported are manufactured and consumer goods. Therefore a transport firm that specializes on certain product groups may experience significant differences in equipment utilisation rates depending on the transport relation.

The demand for freight transport suitable for intermodal transport chains is considerable. For example, the potential volume of EU internal intermodal transport on axis D exceeds 1 million tons per year (chapter 5.1.4). The potential exchange with the Eastern candidate countries is lower. This means that demand for direct long distance relations by intermodal transport in these markets (e.g. Germany-Ukraine) is not strong enough to allow profitable operation of daily direct trains. The relations with the highest potential are generally within main haulage distances of up to 1000 km, where today the truck is in a better competitive position than intermodal transport (see chapter 5.2.3).

Nevertheless the expected strong growth in transport demand between Eastern and Western Europe will steadily increase the potential market for intermodal transport. In other words, changes in economic structure will, on the one hand, lead to increases in freight volumes for a diverse set of goods on single transport relations, and, on the other hand, change the general characteristics of goods transported in a manner difficult to predict.

A good example for how rapid economic development caused significant changes in transport demand is the cluster of automotive industries in the Vienna – Bratislava – Győr region.

6.3.2 Analysis of possible strategies

Given the market analysis, this section analyses three possible market strategies for intermodal transport.

Market Specialization – One possible strategy for intermodal transport is to specialize in movement of certain goods categories (e.g. hazardous goods) that have special transportation requirements. This strategy is recommended in certain cases only, because the commodity flows for hazardous goods are widely dispersed and it is unclear how demand will develop in this market. On the other hand, the higher safety standards of rail transport are an important competitive advantage in this market segment for all distances (short, medium, and long). In cases where there is an existing (or potential) market, main haulage operators should work together with infrastructure companies to make sure that this advantage will not be lost due to reduced maintenance and infrastructure improvements.

Concentration – Concentrating freight flows on particular East-West axes is difficult, because commodity flows are dispersed and not naturally concentrated on certain corridors.
Strategies for Increasing Intermodal Transport between Eastern and Western Europe

(as in Trans-Alpine transport). Therefore the area covered by one axis must not be too small, and interconnections between several axes should be made.

Area-Wide Transport – Development of profitable area wide transport offers does not seem possible given the size of the investigated area. However profitable offers can be realised by an intelligent grouping of several smaller commodity flows, which is a similar strategy compared to operation on large axes.

6.3.3 Conclusions

The best market strategy varies for each type of company involved in the intermodal transport chain (e.g. forwarder, main-haulage operator, pre- and post-haulage operator, terminal operator) and must be chosen according to the company’s general business strategy.

Based on the corridor considered in this analysis, generally speaking the best strategy is a combination of axis and area-wide oriented transport offers. The lower market share for intermodal transport on short and medium distances means that within the EU only a few relations will have high enough freight volumes to justify regular direct train links.

As a consequence, it is necessary to combine different commodity flows efficiently on the main haulage network. The recommendation is to combine goods flows from several less important relationships on to a core network, which is designed based on the high potential transport relations. The principal nodes on this network can be used as the base points to create several regional networks designed to provide service to areas of medium and low demand.

In case a single operator is not capable of operating a proper network by itself and prefers to focus on a single axis strategy, it is essential for the operator to cooperate with other operators to link several axes and regions into an integrated network.

6.4 Operational Strategies

After having discussed the business and market strategies, we have to ask how to physically achieve those goals, i.e. to derive an optimal operational strategy. The focus will be put on operational strategies for the main haulage, because this is one of the processes causing most of the quality problems in intermodal transport. Finally, some recommendations will also be made on terminal operation, since this is another part of the critical process.

6.4.1 Strategies for main haulage operation

Business and market strategies have shown that successful operations will likely be based on operation on single axes and/or operation of networks. In the following section the operational strategies presented in chapter 4.4 will be analysed concerning their suitability for these purposes. Table 6.6 summarises the main characteristics of each system depending on the operational requirements:
### Transport Volumes:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Direct Trains</th>
<th>Feeder Systems</th>
<th>Liner Trains</th>
<th>Hub and spoke Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport Volumes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Large</td>
<td>Optimal</td>
<td>Possible</td>
<td>Unsuitable</td>
<td>Possible</td>
</tr>
<tr>
<td>• Medium</td>
<td>Problematic</td>
<td>Optimal</td>
<td>Optimal</td>
<td>Optimal</td>
</tr>
<tr>
<td>• Small</td>
<td>Impossible</td>
<td>Difficult</td>
<td>Possible</td>
<td>Good</td>
</tr>
</tbody>
</table>

### Variance of Distances:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Direct Trains</th>
<th>Feeder Systems</th>
<th>Liner Trains</th>
<th>Hub and spoke Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance of Distances:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Large</td>
<td>Possible</td>
<td>Possible</td>
<td>&lt;300 km</td>
<td>&lt;500 km</td>
</tr>
<tr>
<td>• Short distances</td>
<td>No problem</td>
<td>No problem</td>
<td>Optimal</td>
<td>No problem</td>
</tr>
</tbody>
</table>

### Networks:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Direct Trains</th>
<th>Feeder Systems</th>
<th>Liner Trains</th>
<th>Hub and spoke Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Networks:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Suitable for network building(^{23})</td>
<td>Unsuitable</td>
<td>Unsuitable</td>
<td>Restricted</td>
<td>Possible</td>
</tr>
<tr>
<td>• Connection with other systems</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
<td>Possible</td>
</tr>
</tbody>
</table>

### Competitivity:

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Direct Trains</th>
<th>Feeder Systems</th>
<th>Liner Trains</th>
<th>Hub and spoke Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitivity:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Efficient in combination with...</td>
<td>Feeder, H&amp;S</td>
<td>Direct, H&amp;S</td>
<td>H&amp;S</td>
<td>Direct, Feeder, Liner</td>
</tr>
</tbody>
</table>

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### Table 6.6: Main haulage operation systems (source: IVT)

#### 6.4.1.1 Direct Trains

Direct train links are the most efficient concept for handling large transport volumes over long, medium and short distances. Although it is difficult to build proper direct train networks, the system can be combined with feeder and/or hub and spoke systems.

The core network mentioned in the market strategies (chapter 6.3) is probably most suitable to be operated with direct trains. The hubs of this network will be able to generate sufficient volumes for establishing profitable regular direct train connections between them. In addition the consignments are forwarded from one major hub in the core network to another, allowing feeder services (see chapter 6.4.1.2) from the regional network surrounding a hub to add volume to the core network.

#### 6.4.1.2 Feeder Systems

Feeder trains are an appropriate system to handle medium transport volumes. Their main purpose is to collect medium or – in special cases – small amounts of cargo from different origins in order to combine them on one axis. Similarly cargo using the core network can be distributed to certain destinations in a regional network using feeder trains.

In this system, feeder trains arriving at the central hub of one region are coupled to form a block train that runs to the destination hub in another region and is re-split. If the number of feeder trains is too small to form an entire block train, one or two of them could be linked with a shuttle train on the core network.

Although a feeder system is not suitable per se to build a network, it might serve well to create an operational connection between the principal network and several regional networks.

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\(^{23}\) I.e. networks without a combination of several systems
6.4.1.3  **Liner Trains**

Like feeder systems, liner trains should mainly be used to transport medium volumes of cargo. In the proposed operating model liner trains could be suitable on both, a regional network and in the principal network.

In a regional network liner trains may be more efficient than a feeder system. If there is a considerable demand for links between the single regional nodes, and if the volumes between them and the central hub are small, a liner train operating as a circle train can serve those regional nodes and at the same time establish a connection to the central hub. The disadvantage compared to a feeder system is the longer average running time for an ITU between its origin/destination and the nearest central hub. If the volumes are great enough to form a separate feeder train from/to one of the regional terminals, this alternative is the more advantageous solution in terms of quality.

Another possibility to operate liner trains is the case of an operating company focussing on one single axis of the core network. Here liner trains might be suitable to serve smaller terminals on the way from one central hub to another, where the volumes are too small to operate direct trains.

Once again, in terms of quality direct trains should be preferred to serve intermediate terminals if the volumes are great enough, because liner trains cause unnecessary waiting times for the through-going consignments.

6.4.1.4  **Hub and spoke Systems**

Any combination of the systems described may be called a hub and spoke system when several branches of a network are linked together in one or several central hubs.

Generally hub and spoke systems are designed to manage medium and small transport flows. Nevertheless a high capacity system of direct trains (as proposed for the core network) with several interconnection points (hubs) also has the structure of a hub and spoke system.

Furthermore, a hub and spoke system might be another alternative for the management of regional networks. If there is no conflict with the operating schedules, a feeder system could be upgraded to a hub and spoke system to gain operating efficiency and thus a reduction of costs. Instead of forming a block train on the principal network a feeder train could link two regional terminals by calling at the central hub to exchange consignment with the core network. In this case the marshalling would have to be replaced by vertical transshipments in the terminal of the central hub. This strategy allows to combine the volume between two regional origins/destinations (of the same region) with transport flows to and from the central hub.

6.4.1.5  **Intermodal transport in combination with wagonload transport**

In practice, the idea of integrating new intermodal networks into existing networks for conventional wagonload transport is not very popular. Intermodal transport is widely considered a completely different and thus incompatible system. Nevertheless this concept should not be left out of the discussion when talking about intermodal transport on East-Western axes.

Several of the operating systems analysed above have certain similarities with wagonload networks – especially the hub and spokes system, where a central intermodal terminal replaces the central marshalling yard used for wagonload systems. Also the feeder system implies a marshalling process for forming block trains.

Therefore intelligent infrastructure planning (new intermodal terminals in the neighbourhood of existing marshalling yards or junctions) might create synergies in both systems:
marshalling yards could be operated at higher capacity, and no special marshalling facilities would have to be built for new intermodal terminals.

On the other hand the big disadvantage of wagonload transport are its cost- and time-consuming marshalling processes. In contrast to the intermodal feeder system entire trains have to be split up and rebuilt completely. This results in low average speed for the main haulage process. Furthermore wagonload transport sometimes uses obsolete rolling stock with lower maximum speeds than in intermodal transport.

We state that the combination of intermodal and wagonload transport may be an alternative, if the volumes for intermodal transport are not sufficient to afford operating a proper intermodal train efficiently at a certain minimum level of service. Still it should be avoided if possible with respect to quality criteria in intermodal transport.

6.4.1.6 Hierarchical System

The proposed strategy for the main haulage process in intermodal transport can be displayed as an integrated model – a hierarchical system divided in three levels of service.

![Hierarchical model for intermodal transport services](source: IVT)

The first and second level represents the proposed intermodal network comprising a principal (or core) network and several regional networks. Level 3 represents the option of integrating intermodal transport in existing networks for wagonload transport.

**Level 1** covers the principal network on a multinational scale. Since the analysis is based on a set of international axes connecting Western and Eastern Europe, these axes form the basic structure of the network. High potential axes (not analysed in this study) running in orthogonal direction provide the interconnections necessary for a proper network structure.
The connecting points represent the central intermodal hubs between which regular direct trains guarantee a constant high level of service and quality. These direct trains may either be shuttle trains (in case of paired and continuous commodity flows) or block trains (in case of grouped feeder services or unpaired commodity flows).

**Level 2** represents a number of regional networks structured around the central hubs of the principal network. Those networks serve to achieve a higher coverage of the market in order to operate the core network at higher capacity. Normally regional networks will not offer international services because of their mostly national service areas, although there may be some exceptions on certain high potential direct interconnections between two regional networks (without using the principal network).

Since regional networks cannot be operated with direct train services, average speeds are lower and operation is less cost efficient than on level 1. Operation modes are normally mixed, based on a hub and spoke or liner trains structure; this depends on each network’s general conditions.

**Level 3** is an appropriate additional solution for all transport flows that cannot be handled with dedicated intermodal services and for private sidings. The quality is lower than on the other two levels, because transport times are longer and operational costs are higher.

The strategy is to operate the existing wagonload networks as before but with additional transport volume generated by intermodal offers. This makes it possible to run more direct trains meaning less marshalling. Intermodal hubs, marshalling yards or junctions may serve as connecting points to the intermodal network (levels 1 and 2).

### 6.4.2 Strategies for terminal operation

In a Swiss research project [9] problems of terminals are identified using interviews and literature review of scientific publications. The main problems identified for existing older terminals in West Europe are:

- High shunting efforts to serve loading tracks (i.e. track length less than train length);
- Poor accessibility on road side (location);
- Insufficient buffer and storage capacity (partly in relation to insufficient cooperation of terminal- and pre- and post-haulage operators);
- Lack of expansion possibilities to accommodate increasing demand;
- Inefficient information and communication systems;
- Inefficient management of damages.

It is likely, based on the overview of East European terminals (see chapter 3.5), that these terminals face the same problems as West European terminals, when transport demand increases.

A key factor seems to be careful planning for new terminals. It is especially important to consider the terminal layout needed for quality optimised and economical operation and for the location (to minimise the pre- and post haulage distances) to be well integrated into the road and railway network. The Swiss research project outlines criteria for optimal terminal planning.

An additional problem is the lack of cooperation between the terminal and the pre- and post haulage operations.

Finally, a significant problem is the lack of initiative in influencing the terminal planning process by intermodal operators and main haulage operators; these partners are in a unique strategic position to influence existing and future terminal owners to do the right things at
right time. They could have a significant influence in improving terminal design and location thus improving the whole intermodal transport network.

6.5 Case Study

6.5.1 General Remarks

A case study has been made in order to give an overview over the results obtained in this project and to check their transferability into real life.

Chapters 2 and 3 have shown that one of the most fast growing transport relations in Europe is the link between Western and South-Eastern Europe, i.e. France, Western Germany and the Benelux states in the West and Slovakia, Hungary and the Balkan/Black Sea region in the East (assigned as axis D).

On this axis D the relation between Duisburg (Germany) and Györ (Hungary) has been chosen to illustrate a possible strategy for the implementation of an improved intermodal transport service. It is based on a European-wide concept for an international intermodal transport network.

6.5.2 Transport Volume

The results of the market analysis (chapter 5.1) show that the link between Duisburg and Györ is of high importance for many of the transport relations along axis D. Duisburg is one of the main hubs in hinterland transport from and to the ARA-ports from where high volume transport flows arrive by rail or waterway to be distributed among the different relations towards Central and Southern Europe. Furthermore, Duisburg’s geographical position in the Ruhr area together with a highly developed logistical infrastructure (port, high capacity rail and road links) generates additional transport volume to and from the local/regional area. The Györ region (including Eastern Slovakia and the Vienna region), too, shows similar characteristics as the Ruhr area with a focus on the automotive industry and its suppliers. It also plays the role of an international logistics hub, where consignments arriving from the West are forwarded towards Hungary, Romania and the Balkan.

We state that the Duisburg – Györ link is one of the most important relations on axis D channelling an important part of the total transport volume between Western and South-Eastern Europe, comparable to the Rhine axis in North – South traffic.

Concerning the potential volumes we see that only the share of EU-internal transport between Germany and Hungary is already 1.8 Mt/a eastbound and 1.5 Mt/a westbound respectively. Assuming that about one third of the volume is handled via the Ruhr area, 0.6 Mt/a (0.5 Mt/a respectively) may be assigned to the described relation. This does not include the volume from Germany further east (Romania and Balkan).

Roughly estimating the overall volume (including all modes of transport) on the relation Duisburg – Györ we are dealing with a scale of 1.0 Mt/a eastbound and 0.8 Mt/a westbound. With a share of approximately 30% actually about 300 kt/a are transported by rail from the Duisburg to the Györ region.

One average full train has a total capacity of 30 consignments. We assume an average use of capacity of 80%, equivalent to 60 TEU. If a twenty-foot equivalent box is loaded with 10 – 12

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24 The ports of Amsterdam, Rotterdam and Antwerp

25 This includes the shipments arriving from the seaports by barge on the Rhine at Duisburg, because the statistics count the change of transport mode (waterway to rail or road) as two separate transport relations, i.e. part of the EU-internal traffic.
tons, the volume carried by one train is between 600 and 720 tons. A regular Monday to Friday service with one train per day means a total of 250 trains per year, altogether transporting a total volume of 150’000 – 180’000 tons. Therefore today 2 trains per day Monday to Friday are necessary to handle the eastbound volume on the example relation.

This overall volume and thus the frequency of rail services are likely to increase in the coming years since the cost ratio between road and rail transport tends to shift in favour of rail (see chapter 5.2).

6.5.3 Intermodal competition and cost

6.5.3.1 Status Quo

To analyse the transport cost for the relation Duisburg – Győr we may refer directly to the example Frankfurt/Main – Krakow used in the cost analysis (chapter 5.2). In both cases the distance is approximately 1000 km.

For the road transport variant Frankfurt – Krakow the calculation gives a total cost of 389 €/TEU, while the intermodal variant is at 466 €/TEU with continuous main haulage and an average pre and post haulage distance of 50 km. In other words intermodal transport is 20% more expensive than road transport.

The Duisburg – Győr link has a different course: assuming that – in order to minimise costs – the route via the Czech Republic and Slovakia is preferred (rather than via Austria) – the same low wage levels for road transport can be applied as in the cost analysis. Instead of Poland, Slovakia and a small part of Hungary are involved. Furthermore, the distance run in Germany is longer than in the example Frankfurt – Krakow. These changes result in an increase of the total costs of about 10% for both transport modes, i.e. road will be at about 430 €/TEU, while rail rises to 510 €/TEU.

This calculation is valid only for consignments from the Ruhr area to the Győr region and vice versa. The ones arriving from the North Sea ports in Duisburg to be forwarded to the East are generally more adequate to be carried by rail, because a great part of them is containerised cargo arriving in great volumes. Pre haulage on the road is not necessary, which reduces the total transport cost by approximately 20%.

6.5.3.2 Future development

When analysing the future development, the cost break-even point is likely to move down the distance axis below 1000 km. The trend scenario analysed in chapter 5.2.4 implies that fuel prices will increase by 50% (compared to summer 2005), an EU-wide toll standard of 0.125 €/km will be implemented and wage costs for road transport in the CEEC will increase by 50%.

Yet actual developments in Europe show a trend towards this scenario: against most analysts’ expectations fuel prices tend to remain on a high level after the strong increase in fall 2005. Furthermore, the Czech Republic and Slovakia will be the next countries in the EU to introduce a road toll system with price levels of approximately 0.14 €/km (CZ) [10]. The systems will start running in 2007. Finally, a new EU directive will come into force in May 2006 replacing the existing directive 2002/15/EC on social legislation in road transport. The key aspect of the new directive is the reduction of the maximum working time from 74 to 56 hours per week together with an elevated minimum number of checks. [11]
This development is likely to accelerate similar measures in the rest of the new EU member countries accelerating the movement towards the trend scenario in chapter 4.2.4. Assuming that the trend scenario will be reached between 2010 and 2015, the cost margin between intermodal and road transport for relations with pre and post haulage (20% today) will be at 5% in favour of intermodal transport (i.e. the intermodal cost level will be at approximately 95% of road transport).

Certainly, this development cannot be directly influenced by the partners in intermodal transport. Efforts have to be made to increase the productivity of intermodal transport itself in order to gain competitiveness. High potential is seen in the optimization of pre and post haulage: raising the average capacity use from 50% to 70% on the 50 km distance reduces the total cost per TEU by 6% (see chapter 6.1.2.4). In combination with the trend scenario this results in a cost advantage of 12% compared to road transport. Therefore concerning transport cost it will be increasingly advantageous to use intermodal transport on the Duisburg – Győr link.

Given a constant quality performance in both transport modes, a possible increase in competitiveness of intermodal transport costs by about one third compared with road transport might likely raise the share of intermodal transport from actually 30% to 40% of the total market volume.

Provided that seaport hinterland traffic will remain on a high level (or increase further) and that the consignors’ requirements concerning quality of service will be met in all respects, intermodal transport may possibly become the most important transport mode on the Duisburg – Győr line and on any long distance relation along axis D with up to 50% market share.

### 6.5.4 Conclusion

If the forecasted development will take place (which is not at all unrealistic), a potential market share between 40% and 50% allows to estimate the eastbound volume to be transported by intermodal transport on the Duisburg – Győr line to 0.4 – 0.5 Mt/a. Given an average annual growth rate for the total market of 2.3% [12], this number may rise up to 0.45 – 0.56 Mt/a within the next five years. This means an additional daily direct train service between Duisburg and Győr (in sum 3 trains per day Monday to Friday). Since the potential volume is similar in the opposite direction (see above), an analog level of service can be established.

If a similar evolution will be realised on other relations (such as Northern or Southern Germany to the Győr region), a total of 3 additional daily trains will be necessary to handle the growing demand. This means that we are dealing with transport flows that allow us to create an efficient service network along axis D: regular shuttle trains operate on three independent lines to handle the volume between Germany and the Győr region that takes over a hub (or gateway) function for consignments further east. Those consignments to be forwarded to Romania or the Balkan region are grouped to form new shuttle trains with a high level of service quality.
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8 Glossary

ACCOMPANIED COMBINED TRANSPORT:
Transport of a complete road vehicle, accompanied by the driver, using another mode of transport (for example ferry or train).

COMBINED TRANSPORT:
Intermodal transport where the major part of the European journey is by rail, inland waterways or sea, and pre- and post-haulage carried out by road is as short as possible.

CONSIGNMENT:
Freight sent under a single contract of carriage.

CONSIGNOR:
A person or company who puts goods in the care of others (freight forwarder, transport operator) to be delivered to a consignee.

CONSIGNEE:
Person or company entitled to take delivery of the goods.

CUSTOMER
Person or company who orders an intermodal transport service from a transport operator or carrier. This person may either be a consignor or a freight forwarder.

FREIGHT FORWARDER:
Intermediary who arranges for the carriage of goods and/or associated services on behalf of a shipper.

HUB:
Central point for the collection, sorting, transshipment and distribution of goods for a particular area.

INTERMODAL PROVIDER
Any person who concludes an intermodal transport contract and assumes the whole responsibility for the performance thereof as a transport operator or carrier.

INTERMODAL TRANSPORT:
The movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes.

In this research project only land-based intermodal transport has been analyzed in detail, i.e. road-rail transport.

INTERMODAL TRANSPORT UNIT (ITU):
Containers, swap bodies and semi-trailers suitable for intermodal transport.

MAIN HAULAGE
Transporting ITUs between origin and destination terminals (by railway in this study’s case). This may either be via a direct connection or via a hub with intermediate transshipment.

PRE- AND POST-HAULAGE
Transporting ITUs by road between terminal and consignor/consignee.

ROAD-RAIL TRANSCHORT:
Combined transport by rail and road.

**SUBCONTRACTOR:**
A third party who performs part of the carriage. In intermodal transport this may be single processes of the transport chain.

**TERMINAL:**
A place equipped for the transshipment and storage of ITUs.

**TEU:**
Twenty-foot Equivalent Unit. A standard unit based on an ISO container of 20 feet length (6.10 m), used as a statistical measure of traffic flows or capacities.

**TRANSSHIPMENT:**
Moving ITUs from one means of transport to another.

**TRANSPORT OPERATOR / CARRIER:**
The person responsible for the carriage of goods, either directly or using a third party.

**UNACCOMPANIED COMBINED TRANSPORT:**
Transport of a road vehicle or an intermodal transport unit (ITU), not accompanied by the driver, using another mode of transport (for example a ferry or a train).