Final Report for Publication

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Project
Co-ordinator: Gruppo CLAS

Partners:

SYSTEMA
INRETS
NEA
CEMAT
DUSS
TFK
MOLBAY

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1. Partnership

Project Co-ordinator

Gruppo CLAS (IT) – Coordinator
Responsible of WP0 – “Project Management”, WP1 “The fundamental variables which affect decisions concerning intermodal transport” and of WP 6 – “Dissemination of results”, partner in WP2, WP3, WP4 and WP5.

Full partners

Systema (GR) - Partner Contractor

INRETS (FR) – Partner Contractor
Responsible of WP5 – “Analysis of the decision-making process in intermodal transport in the case of Rhine corridor” and partner in WP1, WP2 and WP6.

NEA (NL) – Partner Contractor
Responsible for WP2 – “Analysis of the decision-making process in intermodal transport in the case of chemical sector” and partner in WP1, WP2, WP5 and WP6.

CEMAT (IT) – Partner Contractor
Partner in WP2, WP4 and WP5

DUSS (DE) – Partner Contractor
Partner in WP1, WP2 and WP5

TFK (DE) – Partner Contractor
Partner in WP1, WP2 and WP4.

MOLBAY (ES) – Partner Contractor
Partner in WP1, WP2 and WP6.
2. Executive summary

2.1. Objectives

The main objective of the LOGIQ project has been to identify actors in the decision-making process and to provide information on underlining criteria and constraints in the use of intermodal transport. The three categories of variables identified as fundamental in affecting decision taken by actors were a) the infrastructure networks; b) the cost and quality factors influencing the transport chains and actors behaviours; c) the institutional environment of transport and relevant legal issues.

The project has contributed to define the legal, organisational and operational transport requirements arising to the development of concepts related to access to information and day to day business practices.

The two first reports aim at identifying the variables determining the decision-making process and at analysing the decision making process on an empirical basis. The third part used as an input the results of the two first reports to construct a Decision Support System (DSS) for possible computer applications, relating market segments and interrelationships among actors involved. The main objective of the LOGIQ – DSS is to inform decision-makers about the parameters influencing the share of intermodal transport and to assist them in making the right choices in order to increase the use of intermodal transport by a specified user group. The fourth and fifth parts have studied the sector of chemical products and the Rhine traffic corridor.

2.2. Technical description

The first steps for the LOGIQ analysis were based on the preliminary results of IQ project and has been an analytical process and an investigation of the medium/long period decision frameworks. Information concerning the types of actors involved in the transport chains, the distribution of roles and responsibilities among the actors, the types of actors making decisions, the logistics requirements of actors directly concerned have been analysed in order to understand the criteria for using intermodal transport.

The second step of LOGIQ Consortium could be defined as a synthetical process for recomposition of cases of reference. In fact LOGIQ Consortium examined analogies in the characteristics of decision situation identified in the first part and studied similarities and differences among these situations and identifies the criteria which really differentiate decision situations.

The starting point of the analysis was the first IQ differentiation of 23 types of market segments for intermodal transport and their respective quality requirements, the OD classes, as well as the commodity types concerned.

The main hypothesis is that the influence of each actor on the decision-making process is inter-related to the power distribution among actors involved. Therefore, a matrix has been developed in the first phase of LOGIQ, evaluating the power distribution among actors within a transport chain.\(^1\)

The matrix does not directly indicate which actors actually use their influence on the decision-

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\(^1\) The matrix has been developed by TFK in Part Two of Task 1.2 of LOGIQ report, using the F. Vester method (F. Vester, Ausfahrt Zukunft, Munich, 1990). The method relates to the development of a matrix showing which direct influence an actor has on each of the other actors involved in the same system of inter-relationships.
making process. It gives the active power potential of each of the 23 actors considered to drive decisions within a system of inter-relationships in intermodal transport chains. It identifies the actors having the power over other actors and therefore, as so, being of a greater importance within the decision making process.

LOGIQ Consortium carried out an extensive field surveys (92 in depth interviews with shipper, forwarders and shipping lines) in order to be able to indicate which are the most important factors influencing the decision-making process in intermodal transport.

The results of the field survey have been the theoretical background for the Decision Making Process mathematical model that has been developed in WP3.

Two case studies (Chemical sector and Rhine Corridor) contributed to the validation of the analysis of the customer survey and to identify and evaluate the decision criteria in choosing transport solutions and in mode choice in particular.

2.3. Results and conclusions

The results of the LOGIQ field survey can help to understand the relevance of cost and price factors according to the intermodal customers for choosing or not choosing intermodal transport. They also indicate what are the trade-offs between price and quality factors.

LOGIQ Consortium emphasised that the decision-making for using intermodal transport is a quite complicated process. In this process are involved companies’ characteristics, requirements, external factors and supply characteristics and also are inter-related. The attitude of actors towards intermodal transport results from both “objective” characteristics and individual perceptions.

Considering the three actor types (forwarders/ road transport companies, shippers, shipping lines) in an integrated way, LOGIQ researches proved that, among the criteria examined:

1) cost is the most important criterion in the decision-making process;
2) reliability is the most important quality criterion;
3) frequency of services offered and rail operating systems used are the most important criteria considered from the supply side, essentially for meeting the actors’ requirements in reliability.

Flexibility has been proved as less important than the aforementioned criteria. This is explained by the fact that the regularity of shipments is considered as almost a prerequisite for using intermodal transport. The regular users of intermodal transport rarely present very short lead times and therefore, the time horizon available for planning transport operations does not need to be of a high degree of flexibility in most cases. Furthermore, it is shown that the size of shipment (volume per transport order) does not affect the decision-making process. Obviously, it is noticed that for the 100% of cases examined, transport order is more than one loading unit. In the case of shipments less than one loading unit, the impact of this variable on the intermodal share might be major.

Three distinct groups of decision-makers and respectively three decision patterns have been identified as indicated in the following table:

2 Terminal operator, Port Authority, stevedoring company, small shipper, large forwarder, small forwarder, large road haulier, small road haulier, railways, large shipping line/agent, small shipping line/agent, national ministries, EU, labour unions, port owners, local authority, large shipper, intermodal operator railways, intermodal operator like UIRR, inland waterway operator, coastal shipping operator, ferry operator and retailer.
<table>
<thead>
<tr>
<th>Decision-Making Process</th>
<th>Cost Oriented Group</th>
<th>Quality Oriented Group</th>
<th>Specific Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision pattern components</td>
<td>?? Cost</td>
<td>?? Cost</td>
<td>?? Regional-local specificities</td>
</tr>
<tr>
<td></td>
<td>?? Reliability-Flexibility-Safety in an integrated way</td>
<td>?? Additional logistics services</td>
<td>?? Historical reasons</td>
</tr>
<tr>
<td></td>
<td>?? Frequency-operating systems</td>
<td>?? Individual-not generalised perceptions</td>
<td></td>
</tr>
<tr>
<td><strong>Key factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group size</strong></td>
<td>35% of the sample</td>
<td>45% of the sample</td>
<td>20% of the sample</td>
</tr>
<tr>
<td><strong>Intermodal transport usage: range of individual intermodal transport shares</strong></td>
<td>50% - 100% Intensive users Significant market potential</td>
<td>10% - 50% Relatively important market potential</td>
<td>0% - 10%</td>
</tr>
</tbody>
</table>

Statistically accepted correlation between generic groups of decision-makers and professional categories has not been proved. However, some trends have been identified. Shipping lines are mainly represented in the “cost oriented” group and forwarders belong to a large extent to the “cost-quality oriented” group. Moreover, it has been proved that the three decision patterns are not related to commodity types. They are also spatially dispersed within the territory of the European Union.

LOGIQ Consortium also emphasised that there is a strong correlation between cost and quality (in particular speed/flexibility and reliability), in fact very often intermodal customer are able to translate the quality improvements of intermodal services into cost savings.

The variable and criteria found and evaluated in the second phase has been systematized in order to develop a modelling procedure of the decision making process. The result has been a model procedure that take in account the types of actors and their inter-relationship, the influencing variables and their weights, as well as the market segments.

LOGIQ –DSS tool could assist the business developers within a company to decide whether to invest in intermodal transport (e.g. acquisition of new equipment, investments in terminals) offer a new service or improve an existing one. On the other hand it can assist the policy makers (at national governments, European Commission) in deciding which of the measures they can introduce or favour indirectly their implementation, were more appropriate in order to contribute to the objective of increasing the intermodal transport share in the total traffic volume.

Two Chemical sector and Rhine Corridor case studies contributed to identify and evaluate the decision criteria in choosing transport solutions and in mode choice in particular in a very detail manner.

The results of LOGIQ offer a new analytical tool to the European and national transport policy makers. Considering the three distinct groups of decision-makers and the respective decision patterns, the policy makers may investigate in the near future specific measures and actions for promoting intermodal transport. For targeting the potential of the “cost oriented” group, an investigation of possible new policy developments may be needed. The policy initiatives targeting this group should essentially focus on pricing issues and specify economic instruments for
improving the competitive position of intermodal transport in the market. The necessary policy actions in order to take advantage of the potential of the “cost-quality” oriented group must focus on technical, operational and other factors, which might influence the quality performance.
3. Objectives of the project

The main objective of the LOGIQ project has been to identify actors in the decision-making process and to provide information on underlining criteria and constraints in the use of intermodal transport. The three categories of variables identified as fundamental in affecting decision taken by actors were a) the infrastructure networks; b) the cost and quality factors influencing the transport chains and actors behaviours; c) the institutional environment of transport and relevant legal issues.

The better understanding of the decision-making process will assist in defining actions and developing policies in order to increase the share of intermodal transport as a reequilibrium of road transport in the European territory.

The project has contributed to define the legal, organisational and operational transport requirements arising to the development of concepts related to access to information and day to day business practices.

The central objective of the first phase of the project is to provide the first useful information in order to allow the researchers to focus on the crucial aspects and to avoid investigation on non relevant variables in the decision making process in intermodal transport in the following phases of the project.

The second part of the project aim at identifying the variables determining the decision-making process and at analysing the decision making process on an empirical basis through a field survey based on 92 in depth interviews.

The third part used as an input the results of the two first reports to construct a Decision Support System (DSS) for possible computer applications, relating market segments and interrelationships among actors involved. The main objective of the LOGIQ – DSS is to inform decision–makers about the parameters influencing the share of intermodal transport and to assist them in making the right choices in order to increase the use of intermodal transport by a specified user group. The fourth and fifth parts have studied the sector of chemical products and the Rhine traffic corridor.

The results of all the first five phases fed the last part of the project, aimed at the dissemination of the main conclusions achieved.
4. Means used to achieve the objectives

The LOGIQ project started in January 1998 with a duration of 18 months. An extension of three months has been approved by the Commission in June 1999. The request of an extension was due to some difficulties in carrying out the field survey in workpackage n°2. In fact it took a long time to test the questionnaire and to contact companies: some operators refused to be interviewed as they argue they do not perceive the advantages "to keep collaborating with the Commission and the researchers without adequate feed-backs". Therefore the final duration of the project was of 21 months.

4.1. Project Management

Referring to this topics, the project is subdivided into six content related work packages, which consists each of several tasks for a total work of 145 man-months.

WP0: Project Management;
Task 0.1 Day to day management;
Task 0.2 Preparation of reports;
Task 0.3 Validation of results

WP1 The fundamental variables which affect decisions concerning intermodal transport;
Task 1.1. The intermodal transport network and intermodal transport market
Task 1.2 Analysis of the relationship of the actors involved in the intermodal transport chains. Identification of decision-makers for intermodal transport
Task 1.3 Institutional environment and legal issues

WP2 The decision-making process in intermodal transport;
Task 2.1. Analysis of the decision-making process for intermodal transport
Task 2.2. Synthesis of results

WP3 Development of a conceptual model of decision – making process

WP4 Analysis of the decision –making process in intermodal transport in the case of chemical products

WP5 Analysis of the decision-making process in intermodal transport in the case of the Rhine corridor.

WP6 Dissemination of results
Task 6.1 Specialised workshop;
Task 6.2 Establishment and operation of an Internet Site;
Task 6.3 Simulation game among decision makers;
Task 6.4 Production of an handbook;
Task 6.5 International Congress.

Starting with WP1, the work packages and tasks were carried out partly overlapping but in a sequential order. Details on the individual work packages and tasks are described in the following chapter “Scientific and technical description of the project”.

Because of the complexity of its content and the number of partners involved LOGIQ project required a well defined project management and monitoring structure.
A partner has been placed in charge of each Task and Work Package. This ensured good coordination and a harmonised approach within the Tasks and Work Packages.

A four level management and monitoring system had been developed:

- Day-to-day project management
- A Steering Committee
- Workpackage leadership
- Users validation

Lanfranco Senn was the Project Co-ordinator and Gruppo CLAS was responsible for day-to-day project management, including administrative management.

The Project Co-ordinator was supported by a Steering Committee, consisting of highly qualified experts in research in intermodal transport. The Steering Committee controlled the research work and if the deliverables met the quality standards that are required for this project.

The Steering Committee meeting were held regularly, separately or in combination with management and research meeting.

The Steering Committee was chaired by the Project Director, Prof. Lanfranco Senn from Gruppo CLAS. The other members were the Work Package leaders:

- Professor D. Tsamboulas from SYSTEMA
- Mr. C. Reynaud from INRETS
- Mr. H. Vrenken from NEA
- Mr Peter Carderbring of TFK

The co-ordination and scientific management of work carried out in the framework of specific work packages were the responsibility of the respective work package leader. These were:

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<th>Assignment of responsibilities to work packages</th>
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<td>WP3.</td>
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<td>WP4.</td>
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<td>WP5</td>
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<td>WP6</td>
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Although only established for the two workshops, user groups formed to act as external validators of parts of the project.

4.2. Desk research and links with other projects

All the members of LOGIQ Consortium have a long involvement in European research which has been really necessary for the capitalisation of data and results both at European and national level.

It is obvious that important links existed with other projects of the section “Integrated Transport
Chains” of the “Transport Work Programme”. In developing its activities, the project considers not only “IQ – Intermodal Quality” and for the second part of the project “PROMOTIQ – Conditions for the promotion of a new generation of intermodal transport operators and services”, but also cooperation with other projects selected within the third call of the IV Framework Programme: QUATRE MAINS and APRICOT for the decision-making process in the industry and IMPULSE for the improvement of the market penetration to all actors involved in intermodal transport.

Transport journals and magazines of the last 1-2 years, recent literature, conference papers and company brochures also have been used for the research, but EU funded projects and the personal experiences of the researchers were the most important sources.

4.3. Field survey and workshops

LOGIQ project most important result presented the understanding of the decision-making process at the firm’s level, as well as the factors that affect the choice of intermodal transport. They are based on the results of an extensive survey administered to intermodal transport actors across Europe (92 in depth interviews) and exclusively focused on the criteria and individual “mechanisms” governing the decision-making process of transport actors.

The elaboration of results of the field survey followed four distinct stages, briefly presented hereafter.

Stage 1
At the first stage, a very first analysis of the field survey results is undertaken. It provides a verification of the sample units and an overall view of the first findings as well. The various variables of the research are examined separately from each other. This stage is based on descriptive statistics.

Stage 2
At this stage, correlations among variables within the decision pattern of each firm-decision-maker are identified, as well as common patterns in the individual decision-making process. This stage restructures new groups of actors, according to similarities of decision-making patterns. The method used at this stage is Factor Analysis, which identifies the correlation among a large number of inter-related variables by grouping the variables into a few “global variables” called factors. Factor Analysis applied to the whole sample, includes in the best mathematical way all the common information on the variables examined. Furthermore, on the basis of a Hierarchical Cluster Analysis, homogeneous groups of actors, based on the selected factors, are identified. Possible correlations between actors with common decision patterns and actor types (forwarders, shippers or shipping lines) are examined, in order to validate or reject the hypothesis of the first phase. These correlations are examined on the basis of the “Chi-square” test. Finally, this stage identifies correlations between actor groups with common decision patterns and the respective ranges of individual intermodal transport shares. Further specifications on the mathematical methods used are provided in the relevant chapters of the report.

The elaboration of results at this stage is based on the qualitative data of the field survey. These data are essentially related to demand characteristics, assuming that actors with different decision patterns are confronted with the same basic characteristics of intermodal transport supply.

Stage 3
The third stage of elaboration of results is based on quantitative data of the research and explores the supply side. The “actual” quantitative values of various cost and performance characteristics of intermodal and road transport are considered. The supply characteristics are not considered any more as “given” and the impact of hypothetical changes in the supply performance on the individual shares of respondents is calculated.
This stage constructs models for simulating the decision patterns of actors. Various scenarios of performance of intermodal transport supply can be tested, if different values are given to the variables of the relevant models. This mathematical expression of the models has as physical meaning the measure of sensitivity of decision patterns in possible changes of intermodal transport supply. Multiple regression analysis is the most appropriate technique for this stage as it estimates the coefficients of the equation, involving a set of independent variables, that best predicts the value of the dependent variable. Further details on the mathematical methods used and the measurement of fitness of the models derived are presented in the relevant chapter.

Stage 4
The fourth stage of elaboration of results is based on descriptive statistics. It investigates possible associations of the decision-making patterns identified with other characteristics, which do not affect the decision-making process. Stage four investigates possible analogies in decision patterns, in relation to:

- The commodity types;
- The corridors or geographical areas of operations;
- Decisions for ownership of intermodal transport assets;
- The practices of decision-makers and their attitudes towards the establishment of partnerships with intermodal transport service suppliers.

A first workshop held in Athens in September 1998 and organised in the framework of the work for the second phase of LOGIQ validated the analysis and proved that the achieved results correspond to the real conditions of the transport market. The results of the first workshop enriched the field survey results, clarified several aspects and contributed to better understand the decision-making process in intermodal transport.

An useful input for the finalisation of the project has been the exchange of information and opinions with the users’ group during the second workshop held in Annecy (September 1999).

In addition to the conclusion of the results within the Final Report, several documents were produced describing the project findings and submitting it to interested parties. All publications are list in the annex and all the public ones are also available for downloading on the LOGIQ public website.
5. Scientific and technical description of the project

5.1. Introduction

LOGIQ - The decision making process in intermodal transport project aims at identifying the actors in the intermodal transport chains and at evaluating and improving the decision making process for intermodal transport through a better understanding of the importance of three determinant variables: infrastructure, legal framework, behaviour of decision makers.

The better understanding of the decision-making process will assist in defining actions and developing policies in order to increase the share of intermodal transport as a reequilibrium of road transport in the European territory.

The first phase “The fundamental variables which affect decisions concerning intermodal transport” provided the basis needed for the development of the principal research work. In this phase LOGIQ Consortium took the first crucial steps towards identifying actors in the decision-making process and providing information on underlying criteria and constraints in using intermodal transport.

The first in depth investigation permitted to decode the decision of using or not using intermodal transport in operators’ logistic chains as a strategic decision by transport operators. It came out that operators very often consider this decision as a medium/long term decision and they may be influenced by programmers' policies and not only by their own logistic requirements.

Moreover, an important issue of the first phase was to define the first critical steps of the decision process, within the strategic, tactical and operational levels that has been better clarified in the second phase through the field survey.

The first phase of the LOGIQ project categorised the different factors composing the intermodal environment and eventually affecting the decision-making process.

In the second phase “The decision making process in intermodal transport” LOGIQ Consortium evaluated the relative weight of each factor in the process on an empirical basis. This part presented the understanding of the decision-making process at the firm’s level, as well as the factors that affect the choice of intermodal transport. They are based on the results of an extensive survey administered to intermodal transport actors across Europe (92 in depth interviews with transport operators) and exclusively focused on the criteria and individual “mechanisms” governing the decision-making process of transport actors.

The third part “LOGIQ – DSS Decision Support System for intermodal transport” used as an input the results of the two first phases to construct a Decision Process Model (DPM) which is a computer software for the implementation of the decision-making conceptual model developed within LOGIQ.

The case of the chemical products has been studied in the fourth part of LOGIQ “Analysis of the decision-making process in intermodal transport in the case of chemical products”. The last part of the project is a geographical case studies and is titled “Analysis of the decision-making process in intermodal transport in the case of Rhine corridor”.

The results of all the previous phases fed the last one, aimed at the dissemination of the main conclusions achieved.
5.2. The fundamental variables which affect decisions concerning intermodal transport

5.2.1 Introduction

The objectives of the first phase of LOGIQ consisted in examining the variables which affect decisions concerning intermodal transport and identifying actors, their relations and behaviours.

To accomplish this task, the results of previous researches, especially “IQ - Intermodal Quality” have been reviewed, new issues have been investigated and a workshop was held with operators to test the validity of preliminary conclusions.

This phase documented the three variables identified as fundamental in affecting decision taken by actors, which are:

a) the infrastructure networks;

b) the actors behaviour and the power relations among actors influencing the transport chains;

c) the institutional environment of transport and relevant legal issues.

The central objective of this part of the project is to provide the first useful information in order to permit the researchers to focus on the crucial aspects and to avoid investigation on non relevant variables in the decision making process in intermodal transport in the following phases of the project.

5.2.2 The intermodal transport network and intermodal transport market

The aim of this first part of LOGIQ is to provide the data basis needed for the development of the principal research work. In order to achieve this, a synthesis of useful information has been undertaken, concerning the following issues:

- Analysis of intermodal transport chains, quality requirements;
- Analysis of intermodal transport market structures: actors involved in intermodal transport chains and analysis of market segments;
- Technical approach: the European intermodal network infrastructures (characteristics, links, level of services, characterisation of network and transfer points);
- Plans of improvement, expected consequences and impact on demand;
- Definition of corridors, analysis of traffic flows.

The result is the presentation of a panorama of the intermodal transport network in Europe, principally including the network technical characteristics, the market segmentation and a basic traffic analysis.

The purpose of this section is not to present an exhaustive reconstruction of the intermodal transport network, results obtained in other EU funded projects, but is strictly related to the central aim of the LOGIQ project which is the study of the fundamental variables affecting the decision making process in intermodal transport.

The selection of the most appropriate transport mode is a fundamental decision for international distribution, the main criterion being the need to balance costs with customer service requirements. There are very significant trade-offs to be made by the actors when examining the alternatives by considering the different market factors and the different transport chain organisational forms.

In the frame of LOGIQ project, particular attention is paid to the different organisational forms of
door-to-door intermodal transport chains and the rules governing the final choice of users.

*Intermodal transport is the movement of goods in one loading unit, which uses successively several modes of transport without handling of the goods themselves in transhipment between the modes. Several cargo units can be used in intermodal transport, mainly maritime containers, swap bodies and semi-trailers.*

### 5.2.3 The transport market variables affecting actors in the decision making process

LOGIQ Consortium presents certain issues of the transport market, that affect the decision-making process for using intermodal transport. The main objective of this phase of LOGIQ report is to categorise the various aspects of the transport market and underline the strong inter-relationship among the market environment, the actors involved, their strategies and their requirements as well.

The choice of the transport mode is not merely a choice between one form or type of transport, but between a system or process of transportation between the manufacturer or seller and the customer or buyer. This process involves separate sectors (for example, production line to warehouse), intermediary actors, transport means, material handling interfaces and documentation which is processed to support the product.

The final decision for using or not intermodal transport directly relates to the customer requirements. Requirements and decisions considerably vary, according to the characteristics of the goods, the characteristics of the actors involved and their relation, as well as the characteristics of the economic environment. In order to facilitate the process of identification of variables affecting the actors’ decisions, the market issues may be classified into four groups:

- **shipper characteristics;**
- **transport actors’ characteristics;**
- **cargo characteristics;**
- **characteristics of economic environment.**

The four groups of issues of this classification include the criteria of the market segmentation proposed in “IQ-Intermodal Quality” Project (4th Framework Programme, European Commission, DG VII). This has been based on three main criteria: user types (shipper, forwarder, large or small transport road transport company, sea carrier), distance classes (intercontinental chains, continental chains of medium or short distance), commodity types (being either hazardous, perishable, high value general cargo or low value general cargo).

However, within the proposed classification, further criteria having possibly impact on the decision process can be considered, such as the size of companies, not included in the IQ market segmentation.

#### 5.2.4 Shippers’ characteristics

The **size** of the company is a crucial factor relating to the form of transport chains. The size has impact on decisions concerning transport systems because it usually determines the **volumes, frequency and regularity of shipments.**

A possible decision for using intermodal transport acquires different forms: a shipper can own assets for intermodal transport or sub-contracting transport activities to an intermodal operator.

To invest in assets is a strategic decision for actors. It relates to regular and high volume traffic, allowing to achieve the capacity of loads, increasing the productivity of the system.
If frequency and volumes of shipments are fluctuating, decisions for investments in intermodal transport equipment present higher risk and the use of intermodal transport may be a medium or short-term decision. In this case, transport operations can be sub-contracted to a forwarder with intermodal orientation or a door-to-door intermodal operator, if relevant services exist and meet the requirements for delivery time schedules (reliability).

Statistics show that are mainly large companies that make use of intermodal transport. Organisational costs, transaction costs and potential sunk costs deter small companies. These clients, therefore, require specific services that lower these barriers (e.g. neutral end-haulage suppliers, equipment leasing, etc.). Large clients, on the other hand, require low marginal transaction costs such as automated booking and invoicing.

Shippers’ decisions concerning the transport chains organisation are also inter-related to distances. Distances relate to locations. Freight is part of an industrial process. The location of sources for raw materials and other inputs to a production process as well as the location of intermediate and final markets for their products, determine the levels of freight movements involved as well as their origins and destinations. Short distances do not favour the use of intermodal transport, while medium and long distances can favour it, if the other conditions are met.

Furthermore, decisions relating to location or re-location of plants are also of strategic and can be combined with decisions concerning the restructuring of the transport system of the company. This case relates to the strong trend of companies to restructuring their whole logistics systems (production-distribution). Such radical decisions depend on the relative weight of transport cost within the total production-distribution system and the relevant needs for its rationalisation.

Finally, relevant decisions also depend on the perception that shippers have for intermodal transport. As intermodal transport is environmental friendly, certain companies can use it as a means towards the development of an “image” serving marketing strategies. In other cases, even if the use of intermodal transport is financially interesting, shippers consider that, to use intermodal transport is risky. A general perception of a lack of flexibility or of uncertainty in the railway business affect the final decision, even if the particular requirements of operators can be met.

5.2.5 Transport actors’ characteristics

All possible intermediary actor types, involved in the chain between the consignor and the consignee are named here as transport actors. Forwarders, road transport companies, railways, shipping lines, door-to-door intermodal transport operators, other logistics providers are included in this category.

According to the recent legal and institutional framework in the European Union, all these actor types can have access to intermodal transport. Forwarders can establish agreements with door-to-door intermodal transport operators or with terminal-to-terminal operators and sub-contracting pre/end-haulage. Road transport companies can use terminal-to-terminal services and shipping lines can similarly control and organise transport on the inland leg. However, various factors influence a decision concerning the use or non-use of intermodal transport.

Intermodal transport operators are by definition focussed on intermodal transport. Consequently, among transport actors, the choice of using intermodal transport concerns mainly forwarders, road transport companies operating on long distances and logistic services providers as well.

The requirements of transport actors differ from those of shippers. The shipper focuses on maximum safety and reliability but may be less demanding as regards transport speed. The transport company passes the shipper’s requirements to the intermodal operator but also add his own requirements, such as high transport speed in order to have his equipment available and increase productivity (early equipment restriction). The intermodal operator has no choice but to
meet both expectations.

The size of the transport actor is an important factor affecting decisions. In the case of forwarders, the orientation towards intermodal transport is a strategic choice, which has an impact on the whole structure of the company. Investments are needed, in order to establish a network of services, implying a relevant risk. Otherwise, the use of intermodal transport can be an “occasional” choice, as short-term decision among various alternatives. Usually, actors of small size cannot proceed to radical changes in their structure and undertake financial risks.

The activities developed by large logistic services providers and those developed by large forwarders tend to coincide. Forwarders are enlarging the spectrum of services offered and logistic services providers are integrating forwarding functions and extending the control to transport operations.

Road transport large size companies have similar opportunities in using intermodal transport. They can concentrate their activities on pre/end haul operations by increasing the number of round trips and sub-contracting long haulage to terminal-to-terminal operators. On the contrary, small road hauliers usually operate at the local level, where distances do not allow the intermodal transport use.

For large forwarders and hauliers, the intermodal orientation relates to the establishment of a network and not of “linear” services. The network approach ensures the reduction of distances for empty units and rationalise the use of transport means. Consequently, the orientation of forwarders towards intermodal transport strongly relates to the geographical organisation of the customers. The geographical dispersion of plants, either for an in-house services provider or for an actor dealing with numerous customers, determines the choices. The use of intermodal transport relates to the degree of clients’ spatial concentration and the possible routes and trips needed to reach them. These factors also affect the final delivery operations in urban centres.

The adjustment of the required frequency and number of loads to the demand needs the involvement of several actor types (railways, terminal operators etc). Consequently, the strategies of transport actors potentially users of intermodal transport (forwarders) are inter-related to the strategies of actors offering the basic infrastructure management and terminal-to-terminal services. These strategies considerably differ from each other. In the current unstable environment, the “origin” of different actors still determines attitudes towards intermodal transport. The case of rail is an example.

5.2.6 Cargo characteristics

The characteristics and nature of raw materials, semi-final and end products influence the way in which they can be transported: in bulk, packaged in light vans, in very secure vehicles if the products are of a very high value, in refrigerated loading units if they are perishable. Furthermore, the size of packaging differs, according to the commodity types and the size of shipments.

For certain commodity types, unitised cargo is not an appropriate transport unit. The type of loading units also differs: containers, swap bodies, semi-trailers. The European geographical areas differ in the type of loading units normally used. This differentiation implies technical requirements, since handling operations need in certain cases different equipment, transport means and rolling stock. The capability of transport actors to handle various types of loading units appears to be an important criterion for shippers. Similarly, the packaging units do not always allow to use the capacity of loading units. These factors relate to productivity and considerably affect the final decision of customers.
5.2.7 Economic environment

The stability or uncertainty of economic and institutional environment, regional and national specificity and specialisation, as well as the competitive situation in each region affect decisions concerning restructuring of the transport system. The existence of competitive companies offering intermodal services at the local level, the supply of alternative solutions, the features of infrastructure networks affect the decisions. The legal factors are studied in the respective report. The most important factors of economic environment having influence on the decision for using intermodal transport or non-using has been studied in depth, in the framework of the field survey carried out in the second phase of LOGIQ.

The conclusion is that there are many market factors affecting the actors that take part in the intermodal transport chain. It is their responsibility to weight the positive and negative ones and decide which intermodal chain they will use for the goods to be transported. They also have to consider the market factors affecting freight transport, which might change, especially in Europe where the social and economic standards are changing, leading to re-organisation of the transport market. In such an environment, the analysis of rules governing the decision making process for using intermodal transport constitutes an important challenge.

5.2.8 Infrastructural factors affecting the decision making process

Total transit time is one major factor influencing decision makers in intermodal transport. The physical infrastructure characteristics determine partly these transit times. One can think first to the allowed trains speed, that depends on several physical infrastructure characteristics and can be one determinant of the total intermodal transport transit time.

But also the location of terminals and their surface are taken into account as critical infrastructural factor affecting transit time. The characteristics of access links - rail and road - to the terminal, and the limitation in terminal infrastructure - surface limitation resulting in congestion and insufficient internal quality of terminal operations - have been pointed out as critical factors efficiency and quality of intermodal operation.

LOGIQ Consortium presents the European physical infrastructure as a "patchwork" regarding its interoperability. Main examples to illustrate limitations in physical infrastructure and their consequences on transit time are differences in rail gauges (Iberian networks), the differences in voltage, leading to additional traction and/or transhipment operations causing an increase constraints on transit time.

In the LOGIQ project infrastructure issues that have been identified as critical factors in decision-making process are:

- the accessibility to intermodal transport infrastructure and services networks
- the infrastructure constraints and their impact on the quality of intermodal transport services (infrastructure capacity made available for intermodal transport, transit time, reliability...)
- the infrastructure constraints and their impact regarding the intermodal load units (tunnel and bridge gauges...)
- the indirect but essential factor of the infrastructure cost in the determination of the relative price of intermodal transport services compared to total road transport.

But these physical infrastructure characteristics and the constraints they cause in combined transport operations are not presented as the only major factor influencing the quality of the intermodal transport services affecting although the transit time.

Organisational and operational issues have been pointed out, emphasising as critical factor:
- the capacity made available for freight traffic
The number of time slots and the level of priority given to different rail traffic by infrastructure managers or Railways companies appear clearly as a major issue regarding the use of the available physical infrastructure for enhancing capacity and quality of intermodal transport services. For example, the German NETZ 21 approach, Free-Freightways projects and implementation have pointed out the stake of innovation in the use of the available physical infrastructure.

Physical infrastructure limitations on tunnel or bridge gauge, on axe load affect the volume and/or weight of load units, influencing the decision making process in intermodal transport.

Main difference often pointed out in comparing the performance of US and European intermodal transport operation is the possibility given on the US rail infrastructure to operate long double stack intermodal trains. In comparison, the European rail network suffers, for intermodal transport, of several critical tunnel gauge limitations.

As an example, tunnel gauge limitation can influence shipping lines (carrier haulage) or shippers/forwarders (merchant haulage) decision making for intermodal transport when using an '45 maritime containers. Other main examples in Europe are the limitation encountered by the UK rail network to the transport of swap-bodies or the limitation encountered by barge operators in higher stacking container on barges.

This limitations also influence the investment made by combined transport operators and users in innovative wagons (such as the lowered-wagons for UK traffic, the Mega-wagons of ICF...), load units and road equipment for intermodal transport.

Identification of five main infrastructural factors influencing the decision-making process in intermodal transport. Taking into account the results of previous research programmes and the content of a number documents published by UIC, the ECMT, the EC, an hypothesis to be assessed during later stage of the LOGIQ project concerns the following five main infrastructural factors influencing the decision making process in intermodal transport:

- the existence and forecast of increased congestion in the European (road) network, possibly considered as a positive infrastructural factor influencing decision-making process for intermodal transport
- the accessibility to the intermodal transport network and services to be assessed and differentiated according to the decision maker requirements
- the physical infrastructure constraints but also the choice made in the allocation and operation of the available infrastructure in their results in the quality of the intermodal transport services, in transit time and reliability of transit times.
- the physical infrastructure characteristics and the resulting restriction in unit load volume and/or weight
- the physical infrastructure characteristics and the resulting cost

The physical infrastructure characteristics influence greatly the decision making in intermodal transport. In addition to the fact that critical capacity problems are expected to increase, operators point out that problems are also political, financial and commercial. The large TransEuropean projects, if realised, will alleviate several technical and infrastructural physical capacity constraints. But also an evolution in railways operations is expected on available infrastructure. The example of the implementation of Free/freight-ways shows that despite critical bottlenecks at several locations, there are still available margins for the development of intermodal transport. Furthermore the development of innovative intermodal transport operating system such as the "gateway concept" could allow to link efficiently the peripheral areas to the core of rail freight or rail prioritised freight network in the centre of Europe.

The cost and quality of intermodal transport, its ability to serve market requirements, is far from
being determined only by physical infrastructure characteristics and capacity, but relies on many other interdependent elements: availability of rolling stock adapted to infrastructure, operational and organisational choices made by railways companies in the use of the available infrastructure, in the definition of the level of priority given to their different rail traffics; time-tabling consistency for combined transport trains but also capacity and performance at terminal level; efficiency and transparency in procurement and charging systems, contents of transport policies especially regarding infrastructure charging, cost harmonisation with road and other regulatory, financial or fiscal tools for the development of intermodal transport.

Since the decision of operators in choosing intermodal, rather than instead of unimodal transport must be considered as a strategic decision because it is very often taken in the medium/long term and it usually needs new investments (new logistic requirements and equipment, new swap bodies etc), the importance of the analysis of the new plans of infrastructure improvements in medium/long term is crucial in the decision making process for choosing intermodal transport as an alternative to road transport.

New plans of infrastructure improvements have great influence in the choice of the partners for intermodal operators in the logistic chain, on the choice of the location for the warehouses, terminals or plants, and also in the choice of new investment dedicated to intermodal transport equipment.

LOGIQ Consortium presented the main plans of infrastructure improvements of the intermodal network that are potentially relevant for the decision making process in intermodal transport.

At present, many companies of intermodal transport are not able to grasp all the opportunities available on the market for various reasons. In particular some of the obstructive factors are strictly related to the insufficient capacity of intermodal transport infrastructures; such as insufficient terminal capacity, unsuitable time frames for rail capacity, or excessive rates charged for rail transport.

The quality and efficiency of the intermodal transport network is a prerequisite for the creation of a genuine competition among the railway companies, the intermodal transport operators and the road hauliers.

Quality improvement means an improvement of one or several of the following indicators:

- shorter lead times in the intermodal chain;
- more accessible destinations, also on medium and relatively short distance;
- higher reliability;
- more suitable operation times for shippers;
- greater flexibility in time and location;
- lower costs.

The description of the physical infrastructure plans of improvement in European intermodal networks (rail, inland waterways, terminals, harbours and air freight terminals networks) offers to the researchers a crucial tool for further investigation on decision-making process in intermodal transport.

Physical infrastructure constrains such as the limitations in volume or weight or differences in rail gauges or limitations in time slots are one major factor influencing transit time, costs and quality of intermodal transport. Therefore the decision makers consider determinant the quality of intermodal transport infrastructure networks for choosing intermodal transport.

Development of new intermodal transport infrastructure providing still missing links and upgrading the most pronounced bottlenecks can affect both the total transit time and the characteristic of the
load unit and therefore the costs of intermodal transport.

The main results of this report are that only few important projects will have a potential great influence on the decision-making process in intermodal transport. All these plans of improvement concern a segment of European corridors or allow the integration of container harbours with railways networks through new or modernised lines. The new Alpine base tunnels (Frejus, Simplon/Loetschberg Huckepack corridor, Gotthard and Brenner) will permit a great improvement of freight characteristics of the rail connection as the upgrading of the loading gauge, maximum trailing weight and lower pending. This will reduce the traction cost and transit times dramatically. Unfortunately only the Huckepack corridor between Koln and Novara will be completed before 2000, the other projects are still under political discussion. The new dedicated freight line between Rotterdam and Venlo (Betuwe line) and the B1 enlargement of Le Havre - Paris connection will allow better integration among ports and railways network. West Coast Main Line and Nimes-Barcelona projects aims at reducing transit time and upgrade freight characteristics of the line between Continental Europe and Northern England in the first case and between Spain and France in the second case, improving significantly the intermodal transport potential market.

The completion of the Oresund link will reduce the number of operators avoiding the use of ferry for trains coming from Sweden and Norway to Continental Europe and therefore it will lower the transit time from the terminal of origin to destination. The doubling of the Verona-Bologna rail connection and the modernisation of the Mittelland canal will complete the Brenner rail corridor in the first case and the North Sea - Berlin inland waterway corridor, improving in both cases the number of destinations to be reached without changing transport mode.

Concerning maritime transport, consolidation of container flows provokes larger and larger vessels and the necessity of terminals with quay length and draught of sufficient capacity and this factor will increase the network of feeder services. Main harbours both in the Northern range and in the Mediterranean range have already done, or are going to do it in the next future, a complete restructuring with a clear segregation firstly between the container terminals and the other conventional cargo, bulk terminals and secondly between large and medium full container "mother vessel oriented" terminals and medium and small "feeder vessel oriented" container terminals. This factor will positively affect the decision of using intermodal short sea shipping services for inner-European trades because the concept calls for fully integrated (mother vessel/feeder vessel/rail/inland navigation) harbour terminal.

5.2.9 Traffic flows analysis in intermodal transport

LOGIQ Consortium made a review of the existent statistics on traffic flows in intermodal transport completes the panorama of the intermodal transport in Europe.

Intermodal transport demand and supply are not evenly distributed in Europe, but are concentrated on few axes. Despite the fact that the intermodal infrastructure network reaches nearly all regions in Europe, the provision of intermodal services - and its use - seems highly related to few “core intermodal transport corridors”.

Traffic flows in intermodal transport result from a decision making process of many market actors. The market of intermodal transport on certain corridors are seen as an indicator on whether circumstances appear to be more or less favourable intermodal transport.

An exact systematic insight in intermodal traffic is lacking, though. Despite the fact that intermodal freight transport has received significant political attention and is a priority to political decision

3 Dr. Steffen Bukold indicates in “European Combined Transport: passe-partout or placebo?” that more than 90% of international intermodal transport is either related to Germany, transalpine traffic or container traffic on the Rhine.
makers at both national and European levels, intermodal transport has to a large extent remained unknown for politicians, for statisticians and even for some actors in the transport market.

The rail traffic data, which are best documented – the flows carried by UIRR-companies and by ICF – are elaborated in the context of this project, and figures are presented in the Appendix of Report 1.1.4 of LOGIQ.

?? UIRR Flows

?? In terms of transport volume UIRR-members are the major carriers of load units in Europe. It can be observed that combined transport by UIRR members is mainly related to Germany, Italy and Austria.

?? ICF statistics

?? In its annual reports, ICF gives an overview of the total traffic by railway company of origin and destination. Like in the UIRR flows, Germany and Italy are the most important origin and destination countries. Because of the historic specialisation in seaport hinterland flows, the relative importance of Belgium (Antwerp) and Netherlands (Rotterdam) is higher in ICF flows than in (mainly continental) UIRR-flows.

?? In addition to the ICF and UIRR-companies, intermodal rail operators are active

?? in domestic markets. Traditionally, several subsidiaries of railway companies offer domestic intermodal transport services for hinterland container flows. Examples are CNC in France and TFGI in Germany. In a way the service of ECT in the Netherlands could also be ranked in this group. Two other domestic services in the Netherlands are carried out by non-traditional operators: Jonker operates shuttles between Rotterdam and the Northern-Dutch terminals Leeuwarden and Groningen and Rail Terminal Born operates a shuttle between Rotterdam and Born (near Maastricht).

?? In international transport the role of “entrants” in the market is, in terms of market share, of less importance. To mention a few:

?? ERS – owned by deep-sea-carriers - operates international shuttles between Rotterdam seaport and inland terminals in Neuss (D) and in Milan.

?? DTZ runs trains between Munich and Verona.

?? Several services exist between seaports in Benelux and Germany and inland terminals in Eastern-Europe (e.g. Bohemian container Express, Polzug), often offered by joint ventures of companies that are already present in the intermodal transport market.

?? The quite ambitious entrance of NDX Intermodal, offering 5 frequent international shuttles in Europe, could not last for long and the operator had to withdraw again after less than two years after entry, leaving his network to DB-subsidiary TFGI.

The inland container navigation market is geographically even more concentrated than the intermodal rail transport. Roughly the market consists of services between major seaports of Rotterdam and Antwerp and their hinterland in the Netherlands, Belgium and along the Rhine in Germany.

The Rhine Basin can be split up in to three regions, which is in accordance with the operation schedules of barge operators:

?? Upper-Rhine, between Basel (CH) and Kehl (D) / Strassbourg (F). About one third (200,000 - 250,000 TEU) of the total Rhine container traffic has its origin or destination in these regions. The share of inland navigation in the Rotterdam seaport hinterland transport of containers to the Upper-Rhine region is more than 70%.

?? Middle Rhine, between Karlsruhe (D) and Bonn (D). More than 40% (250,000 - 300,000 TEU) of the Rhine container traffic is related to this region. The market share of inland navigation is about 35%.

?? Lower Rhine, between Nijmegen (NL) and Köln (D). About 20% of the Rhine container traffic

4 The UIRR - Union Internationale des sociétés de transport combiné Rail-Route - thanks is high market share of the intermodal transport market to the exclusive position the members had in the provision of combined rail/road services in continental flows. Intercontainer was to provide services in the market of maritime container transport, and still has the major share in these flows.
(100,000 - 150,000 TEU) is for this region. The market share of inland navigation is about 20%.

The market shares decrease when distances decrease. Cost advantages for intermodal transport on shorter distances are lower, due to the additional transshipment costs in the inland terminal and - more important - the relatively high costs of pre- and end-haulage.

In 1996 about 560,000 TEU were carried on the short stretch between seaport terminals in Rotterdam and Antwerp. Whether this flow should be considered as intermodal can be questioned though, because it mainly consists of repositioning flows for deep-sea carriers, with no further connection to inland transport.

In contrast to the rail intermodal transport market, the inland navigation is extremely successful in increasing its market size. E.g. Rhine traffic increased from 400,000 TEU in 1992 to 720,000 TEU in 1996. Dutch domestic transport nearly doubled between 1994 and 1996, after extension of the number of inland barge terminals, which still continues.

In terms of transported volumes, short sea shipping provides a major contribution to intermodal transport in Europe. The intermodal short sea shipping market, which carries about 14 million TEU, can be divided into two sub-markets:

?? Container feederling. This segment is closely related to the intercontinental deep-sea operations. The feeder services link European deep-sea terminals with other deep-sea terminals (repositioning of containers) or with seaport terminals, which are not served by deep-sea vessels on the specific trade. Adding the short sea link to the deep-sea operation is the more cost attractive alternative than extra calls at terminals or than operating smaller sized vessels on deep-sea relations.

?? Ro-Ro services. These are considered as intermodal if it is only the semi-trailer that is carried by the vessel (and not the transport unit). This type of short sea shipping serves continental flows in many regions of Europe. Successful development of these flows could take place due to the absence of appropriate overland alternatives. Many services operate between Scandinavian and Northern German ports, between UK and ports in Germany, Benelux and France, between South European and North African ports and domestic and international transport to and from Greek islands. For some relations there is no alternative (except for trucking on ferries), while for other relations alternatives exist, but are very weak (e.g. Edinburgh – Hamburg or Athens – Bari). On many of these more or less captive short sea transport relations intermodality is restricted to the maritime (port-to-port) part of the chain, and road is used for overland transport. Integrated short sea—inland barge or short-sea-rail services (e.g. Patras – North-Italy) are the exception to this rule.

A special attention has been given to traffic flows in the chemical goods segment and to traffic flows in the Rhine corridor because both traffics will be case-studies of the LOGIQ project in the following phases.

5.3. Analysis of the relationship among actors involved in intermodal transport chains. Identification of decision-makers in intermodal transport.

5.3.1 Inter-relationship among actors involved in intermodal transport chains

The first steps for the LOGIQ analysis were based on the preliminary results of IQ project and then the partners of the Consortium decided to investigate the critical factors that affect the decision making in intermodal transport among the operators who could consider to use intermodality as a complement to road transport.

The core of this first part of the research study has been an analytical process and an investigation of the medium/long period decision frameworks.
A methodological choice of LOGIQ Consortium was to start the analysis process referring to a market segmentation basis as analytical as possible. Considering the recent bibliography, the research project IQ provided this basis. Information concerning the types of actors involved in the transport chains, the distribution of roles and responsibilities among the actors, the types of actors making decisions, the logistics requirements of actors directly concerned have been analysed in order to understand the criteria for using intermodal transport.

In LOGIQ, an insight look is taken into the decision situations that appear if the shipper, forwarder or haulier decides on using (maybe different) transport modes for the shipment of goods that he is responsible for.

The 23 IQ market segments in LOGIQ have been grouped into the following 5 groups.  

a) Maritime transport (market segments 1-6)  
b) Continental transport of hazardous and perishable goods (market segments 7-10)  
c) Continental transport of general cargo for shippers (market segments 11-13)  
d) Continental transport of general cargo for forwarder or road transport company (market segments 14-18)  
e) the “other” segments (market segments 19-23, including captive rail, short sea transport and waste transport).

Various actor types are involved in intermodal transport chains. The analysis per market segment of types of actors’ involvement and inter-relationships in intermodal chains shows that:

?? certain actor types are present in several different market segments;  
?? certain relationship schemes appear in several market segments;  
?? the inter-relationship schemes among actors involved in transport chains considerably differs, even within the same transport market segment;  
?? the involvement and responsibilities of same actor types can differ from case to case.

As stated before, within the 23 IQ market segments, various logistic trends drive the further development of the research. However, some of the market segments show specific logistic developments in their supply chain.

### 5.3.2 Analogies in intermodal decision situations

The second step of LOGIQ Consortium could be defined as a synthetical process for recomposition of cases of reference. In fact LOGIQ Consortium examined analogies in the characteristics of decision situation identified in the first part and studied similarities and differences among these situations and identifies the criteria which really differentiate decision situations.

The first results of this investigation has been an important work of simplification. The starting point of the analysis was the first IQ differentiation of 23 types of market segments for intermodal transport and their respective quality requirements, the O-D classes, as well as the commodity types concerned.

The investigation of the framework of decision-process proved that the criterion of market segmentation used in the first steps of the project does not affect the differentiation of decision situations. The first analysis of LOGIQ discovered that the criteria of definition of decision situation appear to be:

?? the types of decision makers (large shippers, forwarders, large road hauliers or deep sea

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5 For further explanation of the market segmentation please refer to the IQ Deliverable 1
shipping lines); the characteristics of the process of outsourcing activities at different stages of intermodal transport chains.

The organisational forms of transport chains depend more on factors like size of the involved companies, industrial networks they belong, logistics structure, location, legislation, etc, than on market segmentation criteria. In addition, in the various inter-relationship schemes identified by the analysis, the influence of the different actors involved on the transport chains organisation differs considerably.

To impose quality logistics requirements, which affect the chain organisation, is the main criterion for the evaluation of the influence of actors. Influence of actors is of a various degree and extent of items. It is mapped on the types of agreements and contracts among the partners participating in a transport chain functioning. It is also expressed by the communication practices in the chain functioning.

The case of a shipper-decision maker for the whole organisation, who defines the quality parameters to be met and who decides for the actors to execute the respective operations, is different from the case of a shipper-decision maker who defines requirements and allows to a forwarder the freedom to chose the appropriate transport operators, as well the routes and the modalities of transport chain functioning.

Similarly, a forwarder may keep or concede to a transport company the choice of the routes to follow. Thus, there is great variation in the way the actors operate and the processes under which they take their decisions.

As it concerns participation in decision making process, hierarchy levels can be distinguished.

Certain types of actors have important influence on decision-making and keep the control of the whole chain. Other actor types usually make decisions concerning one leg of the complete chain. Finally, other actor types do not participate in any decision process, undertaking a purely “executive” role in transport chains functioning.

According to the organisational form of the chain, the number, kind and respective influence of intermediate actors between the consignor and the consignee differ. Different “chains of agreements” are drawn, reflecting the relative influence of each intermediary actor on the decision making process.

Among actors, decision-makers are possibly the final customers of the intermodal transport operators. The customer is the actor offering the full loading unit as a shipment to the intermodal operator. While intermodal transport is a part of the supply-demand chain, intermodal operators have to fulfil quality requirements set by different actors. Decision-makers, who usually decide on various characteristics of the transport chain such as the mode and actors choice, can be the shipper (consignor or consignee), the logistics services provider, the forwarder and the large road haulier. The shipping lines enter also the scheme at the highest level. A shipping line does not replace the consignor, but it often acts like one, if we only look at the European continental leg of intercontinental maritime transport. If the consignor on the starting point of the intercontinental transport sets requirements that drive the whole transport chain even on the other continent, the shipping line is not free in organising the further transport.

Actors not participating in any decision making process although they influence it indirectly are the terminal-to-terminal intermodal transport operator, the ferry operator, the terminal operator, the railway companies or its subsidiaries, local and government authorities and institutions in the field of transport.

Furthermore, LOGIQ Consortium undertakes an additional approach, in order to evaluate the
relative influence of actors on the decision-making process for structuring intermodal chains.

The main hypothesis is that the influence of each actor on the decision-making process is interrelated to the power distribution among actors involved. Therefore, a matrix has been developed in LOGIQ Deliverable 1, evaluating the power distribution among actors within a transport chain.

The matrix does not directly indicate which actors actually use their influence on the decision-making process. It gives the active power potential of each of the 23 actors considered to drive decisions within a system of inter-relationships in intermodal transport chains. It identifies the actors having the power over other actors and therefore, as so, being of a greater importance within the decision making process.

The actors with strong active power potential will be defined as possible decision-makers, if they belong to the group of potential customers of intermodal transport. These actors have power to structure and control intermodal chains, while other actors are able to partially influence the decision-making process or not at all.

The main conclusion concerning the influence of the various actors on a decision-making process is presented in the following table.

**Table 5. Levels of influence of actor types on the decision-making process**

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<th>LEVELS OF INFLUENCE</th>
<th>ACTORS</th>
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<tr>
<td>Possible Decision-Makers</td>
<td>?? Shipper (Consignor or Consignee)</td>
</tr>
<tr>
<td>In total transport chain</td>
<td>?? Shipping line</td>
</tr>
<tr>
<td>Possible Decision-Makers</td>
<td>?? Forwarder</td>
</tr>
<tr>
<td>In total or in parts of transport chain</td>
<td>?? Large road haulier</td>
</tr>
<tr>
<td>Possible Decision-Makers</td>
<td>?? Railways</td>
</tr>
<tr>
<td>In parts of transport chain</td>
<td>?? Logistics services provider</td>
</tr>
<tr>
<td>No participation in Organisational decisions</td>
<td>?? Intermodal operator (door-to-door services)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LEVELS OF INFLUENCE</th>
<th>ACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Decision-Makers</td>
<td>?? Intermodal operator (terminal to terminal services)</td>
</tr>
<tr>
<td>No participation in Organisational decisions</td>
<td>?? Ferry operator</td>
</tr>
<tr>
<td></td>
<td>?? Barge operator</td>
</tr>
<tr>
<td></td>
<td>?? Terminal operator</td>
</tr>
<tr>
<td></td>
<td>?? Small road haulier</td>
</tr>
</tbody>
</table>

**5.3.3 Identification of decision makers for intermodal transport**

The analysis of decision frameworks carried out by LOGIQ Consortium identified various inter-relationship schemes within the same market segment while almost the same groups of actors and decision situations appear in several market segments. On the other hand, the influence of the

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6 The matrix has been developed by TFK in Part Two of Task 1.2 of LOGIQ report, using the F. Vester method (F. Vester, Ausfahrt Zukunft, Munich, 1990). The method relates to the development of a matrix showing which direct influence an actor has on each of the other actors involved in the same system of inter-relationships.

7 Terminal operator, Port Authority, stevedoring company, small shipper, large forwarder, small forwarder, large road haulier, small road haulier, railways, large shipping line/agent, small shipping line/agent, national ministries, EU, labour unions, port owners, local authority, large shipper, intermodal operator railways, intermodal operator like UIRR, inland waterway operator, coastal shipping operator, ferry operator and retailer.
different actors on the transport chains structure differs considerably.

Among a large number, a few actors appear as decision-makers in transport chains organisation and also few actors have partially influence on the decision process.

Large shippers, large forwarders and deep sea shipping lines (in the case of maritime transport) are the actors-customers imposing requirements and making decision in intermodal transport chains, owning assets or not. Certain logistic services providers play also an important role in the power distribution. Finally, certain large road carriers have enlarged the spectrum of the services they provide, increasing considerably their power potential in the decision-making process. These road carriers present strong similarities with the forwarders.

An useful results for RECORDIT project coming from LOGIQ is that the investigation of the framework of decision-process proved that the criterion of market segmentation does not affect the differentiation of decision situations.

The organisational forms of the transport chains depend more on factors like size of the involved companies, industrial networks they belong, logistic structure and policy framework (long term planning and business strategic decision).

The investigation of the criteria governing the decision-making process requires the definition of the decision situations of reference, in order to develop an appropriate field survey.

5.3.4. Representative decision situations of reference

According to the type of decision makers and the level of outsourcing criteria and taking into account the results of a workshop with intermodal operators, LOGIQ identified the following representative decision situations of reference:

Case 1

Decision-maker: Large shipper owning assets and operating own account transport and logistics activities. It is interesting to investigate how “own assets” affect the usage of intermodal transport. Investments in intermodal equipment can result from a decision process to use intermodal transport. Therefore, the decision process is influenced by the necessity to optimise the own assets use. Finally, to further evaluate the influence of own assets on decision, the different types of own assets and the respective types of actors must be taken into consideration.

Case 2

Decision-maker: Large shipper directly contracting out transport activities and ensuring own account forwarding and logistic activities.

Case 3

Decision-maker: Large forwarder having the freedom to chose transport modes, routes and transport operators to carry out transport functions. In case 3, shippers, however, impose the quality of parameters of transport (frequency, dispatch size, delivery time etc).

Case 4

Decision-maker: Large forwarder or large road transport company operating for the account of a large number of shippers of various size.
Case 5

Decision-maker: Deep sea shipping line or feeder operator also organising the transport and logistics activities on the inland leg. Two sub-cases can be distinguished:

5a: merchant haulage
5b: carrier haulage

These important simplification results are not based only on the results of IQ project; the research study has also been integrated with a theoretical analysis and with a direct comparison with the actors’ point of view emerged during the workshop.

The analysis allowed to highlight also the factors that affect the medium/long period strategic decisions concerning the investment for intermodal transport equipment. In fact this enlarged analysis defines the links between macroeconomic decisions (such as political decisions, regulations and infrastructure investments) and microeconomic decisions (such as investing or not in Intermodal transport equipment).

The investigation on LOGIQ enabled to decode the decision of using or not using intermodal transport in operator’s logistic chains as a strategic decision by transport operators. It came out that operators very often consider this decision as a medium/long term decision and they may be influenced by programmers’ policies and not only by their own logistic requirements.

5.4. Institutional environment and legal issues

The research accomplished in the first phase of LOGIQ clarified and documented the following conclusions: the institutional environment and legal issues affect the operational choices as the infrastructure network, but they are much more relevant in affecting strategic decisions.

Regulations and transport policies have to be taken into account as determinant of competition, technical and operational issues for intermodal transport. As government’s and European transport policies and regulations appear as the most important external factor for development of the intermodal transport system, the regulations and administrative decisions concerning technical control, safety gauges and labour laws shall allow full interoperability in the intermodal transport system.

Successful integration of the operators in complex intermodal transport chains needs to be supported firstly by adequate, harmonised European regulations. A first dimension is then the adequation and harmonisation of the legal and technical framework for international intermodal transports. Lack of European harmonisation in infrastructure characteristics and mode contribution to infrastructure cost, in operations rules and in regulations or their implementation, appears as a major obstacle to a full interoperability in international intermodal transport.

Successful integration of the operators in complex intermodal transport chains need to be supported by adequate, harmonised-coherent regulations as regards the different modes of transport involved in one single transport chain.

Adequate European and national administrative decisions need to prevent conflicts between actors of different transport modalities arising from different modal regulations. In other words, a global interoperability must be ensured, that refers both to the improved interconnection/co-operation between actors, parts of the intermodal transport systems (infrastructure, equipment, standardisation, borders etc.) and the various countries as well as to the improved integration between legislation, organisation and technology.
LOGIQ documented very well the fact that no acts, laws or provision regulating access to a profession of intermodal transport operators have been discovered in any country of the European Union. These activities are considered to be related to modal mix operations.

The professionals involved in these intermodal transport activities are not regarded as members of a proper professional body and therefore any problems have to be evaluated indirectly through the application of laws and regulations regarding other basic transport modes used within the intermodal transport chain.

LOGIQ Consortium distinguished the regulations and administrative decisions that have a direct impact on operations and the general political and legal framework for fair competition between modes and between actors in the intermodal transport sector that have a more indirect impact on intermodal operations but also raise conflicts between actors.

Several sectorial regulations and administrative decisions have a direct impact on intermodal operations:
1. Limitation for road transport operations: maximum gross mass allowed for road transport, driving bans;
2. Labour laws for road operations: the payment of all working periods;
3. Limitations for terminal operations: hours of operations, handling of dangerous cargo;
4. Limitations for trains operations: the existence of interactions between infrastructure characteristics and choices in rail operations;
5. Lack of operational and administrative co-ordination/co-operation between railway companies resulting in high delays for border crossing and low reliability of international train services.
6. Increase in the number of types of unit loads and wagons: a conflict between the search for industrialisation and standardisation of the processes and the search for flexibility and adaptability to the demand;
7. Complexity and lack of harmonisation in procedures for the introduction of new equipment;
8. Adaptation of all administrative procedures to paperless and computerised procedures;
9. High transaction costs and slow market response from the railways;
10. Capacity bottlenecks and complex and long infrastructure planning and financing process;
11. Lack of intermodal liability regime.

The sectorial regulations and administrative decisions resulting from present national and European transport policies define a framework for intermodal operations that, with more indirect impact on intermodal transport operations, also raise conflict between the actors.

In preparing the gradual integration of European transport markets, and in particular of the European rail market, Community directives and regulations constitute the legal instruments to create a legal environment that will ensure the interoperability of national networks and the development of a truly trans-European rail network on which sound, efficient and competitive railway activity will operate.

We do not intend here to review all the turbulence at the institutional level following European Commission directives on rail transport sector, but to mention the possible impact of the various changes as regards intermodal operations, pointing out the possible conflicts or complications in decision making that results indirectly from those changes in the legal and institutional framework.

Thus, besides legislation limiting road operations, notably the regulations about maximum driving and minimum resting hours in road transport, a particular concern for intermodal operation are the modalities and level of contribution of intermodal transport to the costs of infrastructure. Finally, recent and non uniform implementation of European Directive 91/440, 95/18 and 95/19 raise complications and conflict in decision process for combined transport operators and users.

The policy measures of European Union and their effects on competition among actors in the intermodal transport market have been studied and documented in Report 1.3.2.

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8 "Phare study on the conditions for the progressive integration of European inland transport markets ", March 1998
The policy measures of European Union concerning transport have to combine the acceleration of the single transport market and the free access to the market with the alleviation of several problems related to the inefficiency of the transport systems. Besides, the European Union aims at creating favourable conditions in order to adjust the transport systems to the new logistics requirements of users. Plans of improvement of the various infrastructure networks are also developed in the framework of the European transport policy.

5.4.1 European policy measures and decisions: effect on competition among actors in the intermodal transport market.

LOGIQ Consortium presented the European policy measures and decisions having impact on the structure and competition in the transport market. As the positioning of actors and the competition in the intermodal transport market is inter-related to changes in the entire transport environment, except for the measures and decisions directly concerning intermodal transport, LOGIQ examined policy decisions concerning the various transport modes. Effects on the competition between actors of the same or different transport modes will be identified.

Several European Policy measures relate to road transport and cover different aspects of road transport market, such as carriage between member-states, safeguard mechanisms, safety for the transport of dangerous goods, taxation, mutual recognition of diplomas, use of vehicles without drivers.

In the context of the development of the Community's railways and in order to grant the right of access to railway infrastructure to actors wishing to provide international combined transport services, as well as to associations of railway "families" wishing to offer international services published the Council Directive 91/440/EEC of 29 July 1991. Directive 440/91 is of major importance, implying radical changes in the European transport environment.

The aim of the Directive is to facilitate the adaptation of the Community's railways to the needs of the single market and to increase their efficiency, in particular by separating the management of railway operation and infrastructure from the provision of railway transport services.

Other critical matters, as far as rail transport is concerned, are the licensing of railways actors, the allocation of railway infrastructure capacity and the charging of infrastructure fees.

The White Paper titled "A strategy for revitalising the Community's railways" is another important policy document of the Community for the competitiveness in the intermodal transport market. The objective is to lay down a strategy to revitalise the Community's railways by creating a sound financial basis, ensuring freedom of access to all traffic and public services and by promoting the integration of national systems and social aspects.

Further work followed by the community are the Commission Communication - COM(97) 242 final of 29 May 1997, on trans-European rail freight freeways. In this communication, the Commission advocates the introduction of rail corridors to operate following the principle of access to freeways. This must be fair, equal and non-discriminatory for all train operators licensed in the Community.

The granting of licences, allocation of infrastructure capacity and charging of infrastructure fees within the framework of these freeways should be in compliance with Directives 95/18/EC and 95/19/EC. Freeways should be open to cabotage and freight terminals should be open for fair, equal and non-discriminatory access to all train, road haulage and waterway operators.

Several measures and decisions have been taken by the European Union responsible bodies, as it
concerns various aspects of waterways transport. Among the aspects, particular importance is paid to structural improvements in the market of inland waterways transport, the conditions under which non-resident carriers may have freedom to operate inland waterways transport in a Member-State, the conditions for obtaining certificates, issues of chartering and pricing and waterways transport of dangerous goods as well.

LOGIQ presented the policy decisions that have been taken by the Community as it concerns maritime transport. The establishment of freedom to supply services between Member-States, between Member-States and third countries or within a Member-State is the main objective of European policy towards the maritime transport re-organisation, in accordance with the basic principles of Community law.

In the framework of European transport policy, particular attention is given to short-sea-shipping. The development of short-distance transport by sea is among the priorities of European transport policy. The outlook and challenges for the development of short-distance transport by sea in Europe, as well as relevant incentives, are presented in the Commission Communication of 5 July 1995.

This communication concerns transport by sea along the coasts of the European Union and between the continental ports and islands of the Union. It sets out a number of recommendations put to the Member States, the regional and local authorities, and also to the maritime industries on means of improving competitiveness in this sector. It advocates short-distance transport by sea by stressing that this mode of transport consumes less energy and constitutes a non-polluting alternative to road transport. It also stresses the need to improve the quality and efficiency of coastal shipping, the infrastructure and port capacity and of preparing coastal shipping for future enlargement. In addition, it examines purely internal transport (cabotage) and cross-border transport either within the Union or between it and the adjacent regions. It covers river/sea transport.

The objective of promotion of transport of goods by means of the interconnection of different modes of transport throughout the European Union, conducted the Community to also focus on infrastructural issues and to accelerate procedures for the integration of national infrastructure networks. In this framework, the Community published the Council Decision 93/628/EEC of 29 October 1993 on the creation of the trans-European combined transport network.

According to the Decision, the basic trans-European combined transport network will consist of rail and inland waterway routes and road links which are of major importance for long-distance freight transport and provide connections to all Member States. It also includes facilities for transhipment between rail, inland waterway, road and sea transport.

As further contribution to the promotion of combined transport, the European Commission is developing the PACT (Pilot Action for Combined Transport) Programme. The proposal is intended to establish a mechanism for granting financial assistance for pilot projects to promote the combined transport of goods (Pact programme). This programme covers a period of five years (1 Jan. 1997 to 31 Dec. 2001). The objectives pursued are to increase the competitiveness of combined transport both in terms of price and of service quality against road transport, to promote the use of advanced technology in the combined transport sector and to improve access to combined transport.

On 29 May 1997, after implementing various actions and decisions concerning intermodal and combined transport, the Commission presented the Communication No 243. This Communication constitutes a synthesis of the general principles and the situation as concerns intermodality in European Union. It creates a background guaranteeing optimum integration of the various transport modes in such a way as to offer continuous door-to-door services meeting customer needs and enabling the transport system to be used efficiently and profitably while promoting competition between the operators. Communication 243 provides a system approach for the carriage of goods. It elaborates strategies and activities intended to promote efficiency, services and sustainable
development.

In Communication 243 intermodality is not intended to impose a particular mode option, but enables better use to be made of the railways, inland waterways and transport by sea, which individually cannot provide a door-to-door service. Intermodality has been added to the other transport policies conducted by the European Union, more particularly with a view to liberalising the transport market, developing the trans-European networks (TEN), promoting fair, efficient pricing and bringing the information society to the transport industry.

There is a rapidly changing and increasingly complex legal framework within which, the transport chain actors must operate. The actors have to be sure they are one stop ahead of the forthcoming legislation, so that when changes in the law come into force, they can adapt the transport operation smoothly to the new requirements. They must also be able to accommodate any future cost implications and, most important of all, anticipate the impact that changes in the transport operation will have on the rest of the company’s logistics system. This might, for example, concern packaging, warehousing and customer service—or even the overall distribution strategy.

The impact of legislation is clearly significant and can influence the trends of the transport market, as well as the actors’ strategies. The current EU policy aims to set free of restrictions, some trends that exist in the freight transport market and accelerate these trends, when they lead to regulation and not to crises or bottlenecks. Despite this effort, there will certainly be in the future cases that where these fairly new regulations will bring hard times to the freight transport market, instead of solving old problems and that will be the case mostly at a regional level. Special infrastructure or topographical characteristics make a region or a market distinct and therefore general rules cannot be applied.

There are significant opportunities for the actors to develop the scope of their services across the community as a whole since distribution and transport can be bought in any country. On the other hand, actors operating exclusively at a national level, will find it hard to compete with the international operators that now can transport goods within any Member-State of the European Union.

The main issue between the major changes in the European Union market is that of cabotage. The EU is aiming at a full cabotage, reducing the empty freight movements in transport chains. This will bring more competition between the actors, especially those active in third party distribution, due to the increased market. There will also be an incentive for joint ventures with other European actors to enable pan-European integrated distribution structure to be realised.

5.4.2 Transport through the Alps

LOGIQ Consortium presented the legal issues and the institutional environment regarding goods transport through the Alps. The problem of Alpine traffic has been considered as a good example because it permitted to check the importance of artificial and natural barriers against road transport and the effects on intermodal transport traffics and it has been a good input for the following phases of the project when the research Consortium will evaluate the relative weight of each factor in the process of decision making in intermodal transport.

The focus has been on the situation of Austria and Switzerland as transit countries and on France, Germany and Italy as neighbouring countries. Furthermore, a description of the Slovenian situation is included in view of the integration of Slovenia into the EU in the near future.
The Alps constitute a particularly problematic region, both from a transport and a geographical perspective. Goods flows are concentrated on few routes and Alpine regions are ecologically more sensitive, and the little space available for inhabitants and construction has to be shared with the traffic infrastructure.

The Alpine Arch stretches from the Alps Maritimes to the Viennese Basin, including Austria, France and Switzerland. Around 64 million tons of freight were transported through the Alps in 1994; 43% of this volume being accounted for by Austria, 30% by France and the remaining 27% by Switzerland. According to a recent study, freight transport across the Alps is set to grow by 75% between 1992 and 2010 (given the expected economic growth in Europe), which amounts to an annual growth of more than 3%.

Austria and Switzerland are willing to meet their responsibilities as transit countries, especially as the prosperity of both countries depends to a considerable extent on a smooth flow of external trade. Austria's entry into the EU in 1995 has increased still further the need for free movement of goods and services. However, both governments insist that rail should carry as much as possible of the transit freight traffic.

Current Swiss land transport policies, coupled with the general trend of increasing road traffic, have led to diversion of traffic, extra costs and environmental damage in the Alpine region. Austria and France have serious problems with high levels of transit traffic, a large proportion of which are the result of diversion due to the Swiss limit of 28t for heavy goods vehicles when most European international fleets are made up of loaded trucks of 40t.

The economic consequences of the Swiss policy are felt by every Member State because of the higher transport costs that result from half empty lorries crossing Switzerland or from diversion around Switzerland. The total cost to EU business of diversion is conservatively estimated at 160 million ECU per year, not taking into account the costs of congestion, environmental, air and noise pollution and accidents of these longer journeys.

The European Commission intends to adopt large-scale measures in order to guarantee sustainable transport in a long-term vision. The objectives of the Common Transport Policy, relevant to the Alpine area, can be summed up as follows:

- The creation of an efficient multimodal transport system based on the principles of a market economy; no governmental regulation of capacities supplied by the transport companies; free price formation and a market-oriented framework;
- The achievement of a sustainable mobility through effective regulations for environmental protection and transport safety, taking into account the harmonisation of the competitive framework for the transport modes;
- Non-discrimination of transport operators with respect to their nationality, their location or the type of transport (national/international);
- The equivalence in the effectiveness of regulations on EU territory on the one hand, and on Swiss territory on the other hand. The principle of the shortest path should be realised and transport detours should be avoided.

Both Austria and Switzerland government's policy insist that rail should carry as much as possible

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9 “Study of the Development of Transalpine Traffic - Horizon 2010” by Prognos AG (Vienna), Regional Consulting (Basle) and ISIS (Paris), 1998; commissioned by the European Commission and backed by the Transport Ministries of Germany, France, Italy, Austria and Switzerland.

10 Source: European Commission, DG VII, 1997

11 Source: Study of the Development of Transalpine Traffic
of the transit freight traffic and imposed restrictions on the movement of heavy vehicles and supported intermodal transport also with financial aids.

The most important policies regarding goods transport through the Alps are the "ecopoint system" in Austria and the initiative "for the Protection of the Alpine Region from Transit Traffic" in Switzerland.

During accession negotiations of Austria to enter the EU, among the issues that seriously menaced Austria’s integration into the Common Market, the transit traffic through Austria remained an apparently unsolvable obstacle throughout the discussions.

As a result, the previously existing bilateral Transit Agreement between Austria and the EU was almost entirely integrated into Protocol N° 9, the Treaty concluding Austria’s accession to the EU. In particular, it was agreed that the so-called "Ecopoint system" would be maintained, although strictly speaking, the system constitutes a barrier to the free movement of goods - one of the pillars of the Common Market. The exception was admitted because it is a measure aiming at the preservation of the environment and therefore a matter of Community interest.

On 20 February 1994 the Swiss people approved the initiative “for the Protection of the Alpine Region from Transit Traffic”. As a result, an article on the protection of the Alps was added to the Federal Constitution, establishing that all transport of goods by road in transit through the Swiss territory will be transferred on rail within ten years from 1 January 1995. Furthermore, the article establishes that the capacity of the transit roads in the Alpine region cannot be increased.

In order to apply the article on the protection of the Alps, the Federal Council elaborated a program in September 1994, based on:

- a tax on heavy vehicle traffic, calculated on the maximum permissible weight, kilometres run, emissions and consumption of the vehicle (approved by a referendum, which was held on 27 September 1998);
- an additional tax on heavy vehicle traffic through the Alps (tax on Alpine Transit);
- the promotion of combined transport (development of railway supplies which are of interest to the transalpine transit traffic).

In the framework of the bilateral negotiations between Switzerland and the EU, the abolition of the 28t weight limit for heavy vehicles in transit through Switzerland is envisaged. Other measures with a comparable effect, but based on market rules, should substitute this restriction. Starting from 2001 and parallel to the introduction of the heavy vehicle and transit taxes, the weight limit will be gradually increased until 2005, when it will reach 40t. During the transition period, the transit of 200,000 trucks with a GVW of 40t will be authorized in the years 2001 and 2002, going up to 300,000 trucks for 2003 and 2004.

5.5. The decision-making process in intermodal transport

5.5.1. Introduction

The main objective of the second phase of LOGIQ project has been the analysis of the decision-making process of transport actors for using or not intermodal transport. To achieve this objective, LOGIQ aimed at:

- the specification of the key variables for the most common situations in deciding whether to use intermodal transport ;
The identification of actor groups having common attitudes towards intermodal transport;
the identification of decision patterns, on the basis of which the choice of intermodal transport is made;
the definition of the extent to which changes in the values of relevant variables may shift a decision towards the use of intermodal transport.

The depiction of the decision-making process tests the basic requirements from demand side, reveals the transport actors’ priorities and allows the synthesis of actors’ attitudes towards intermodal transport. The research identifies constraints of various natures in choosing intermodal transport and contributes to specify further actions and policy measures for improving intermodal transport systems.

The decision patterns identified will form the basis for the construction of the Decision Support System (DSS) work. The objective of DSS is to elaborate scenarios and “desired options” as far as the decision framework is concerned. The DSS will provide the impact of identified or hypothetical situations on the intermodal transport share of potential users. DSS is expected to be an efficient tool for policy makers and transport actors as well.

The organisation of the field survey for the analysis of the decision-making process presupposes an accurate definition of the framework within which decisions are taken. The decision framework consists of a large number of components relating to market, actors, infrastructure, legislation and technology. It also relates to important organisational issues in economy, production and distribution systems. Characteristics internal to the company-actor and external - to the “environment” they operate- structure the frameworks in which the transport actors develop their attitudes towards intermodal transport.

The construction of decision frameworks has been undertaken at the 1st stage of LOGIQ project. That stage of the research drew conclusions on infrastructure networks, nodes and links and the relevant variables which may affect decisions. It also studied the market factors, legal and institutional framework and identified those variables, which may influence the users’ decisions.

The empirical analysis concluded that differentiation in decision situations depend on the following parameters:

- differentiation based on the actor-type decision-maker (large shipper, forwarder, large road haulier or shipping line)
- differentiation based on outsourcing processes.

While the first phase analysed the decision framework on an empirical basis and it identified the actor types decision-makers and the variables possibly affecting the decision-making process for using intermodal transport, the second phase analysed the decision-making process.

The results of the first phase built the basic hypotheses for the analysis of decision-making process. The organisation of the field survey, the structure of the questionnaires and the theoretical assumptions of analysis are largely based on the results of first phase.

### 5.5.2 Data collection

According to the results of the first phase of LOGIQ, three types of actors-decision-makers have been interviewed with three different questionnaires:

- forwarders/road hauliers (46);
- shippers (32);
The questionnaires include questions aimed at identifying the variables affecting the decision-making process for using intermodal transport. They are divided into four main sections, according to the nature of data required.

The first section is related to general characteristics of traffic volumes of the respondent, including the intermodal share. The second section includes data focused on a representative intermodal transport flow of the respondent. The variables affecting the decision-making process of respondents (as defined in WP1 of the project) are tested for their relevance. The quantitative data collected generally relate to cost variable, company factors, quality requirements and supply characteristics.

This section of the questionnaire undertakes a comparison between intermodal and road transport cost on a specific link and collects data on regularity, frequency and size of transport orders. It also investigates the respective “critical” values determining the decision for using intermodal transport.

Similarly, “critical” values of performance indicators are asked, for quality variables affecting the decision-making process. The quality indicators used are:

- reliability: maximum accepted delay and maximum frequency of delays
- flexibility: maximum time span between the order is placed and the moment that the loading unit is offered for dispatch and minimum required time to dispatch the loading unit
- safety: maximum acceptable damages and number of damages per year.

Furthermore, additional information is collected for better understanding the decision-making process and the context of decision-making. Open-ended or closed questions relate to the following factors internal and external to the company:

- the warehouse location of the company
- unprogrammed transport operations
- ownership of intermodal transport assets
- the rail operating systems
- infrastructural constraints.

Moreover, this section focuses on “historical” issues related to the use of intermodal transport, the establishment of partnerships and the competition on supply side. At the end of this section, the respondents weight the importance of each variable.

The third section of the questionnaire focuses on several characteristics related to a representative road flow of the interviewed company. Asking questions similar to the previous section, the third section allows comparisons. It also investigates the respective intermodal transport supply characteristics on this route, for which the respondent prefers using road transport.

Finally, the fourth section relates to policy issues. The respondents underline the main conditions for using intermodal transport and the main issues leading to improvement of intermodal transport performance.

The elaboration of results followed four different stages, briefly presented in the Chapter 4 “Means used to achieve the objectives”.

5.5.3 Results of the field survey

The results of the LOGIQ field survey can be an interesting input to understand the relevance of
cost and price factors according to the intermodal customers for choosing or not choosing intermodal transport. They also indicate what are the trade-offs between price and quality factors.

LOGIQ Consortium emphasised that the decision-making for using intermodal transport is a quite complicated process. In this process are involved companies’ characteristics, requirements, external factors and supply characteristics and also are inter-related. The attitude of actors towards intermodal transport results from both “objective” characteristics and individual perceptions.

Considering the three actor types (forwarders/road transport companies, shippers, shipping lines) in an integrated way, LOGIQ researches proved that, among the criteria examined:

1. **cost** is the most important criterion in the decision-making process;
2. **reliability** is the most important quality criterion;
3. **frequency of services offered** and **rail operating systems** used are the most important criteria considered from the supply side, essentially for meeting the actors’ requirements in reliability.

Flexibility has been proved as less important than the aforementioned criteria. This is explained by the fact that the regularity of shipments is considered as almost a prerequisite for using intermodal transport. The regular users of intermodal transport rarely present very short lead times and therefore, the time horizon available for planning transport operations does not need to be of a high degree of flexibility in most cases. Furthermore, it is shown that the size of shipment (volume per transport order) does not affect the decision-making process. Obviously, it is noticed that for the 100% of cases examined, transport order is more than one loading unit. In the case of shipments less than one loading unit, the impact of this variable on the intermodal share might be major.

However, even if the “absolute” importance of the cost factor is confirmed, in many cases cost does not really determine the modal choice.

This is due to the very small difference between actual prices of intermodal and road transport cost in certain heavy-flow corridors in the European transport market. At equal or close prices for a given transport distance, the cost factor becomes “neutral” and the other variables finally affect the choice of users.

Similarly, other “objectively” important criteria examined, such as safety, commodity types, ownership of assets etc, are not determinant for the decision-making process itself. This is due to the fact that the users consider the performance of intermodal as similar to that of road transport, as far as these criteria are concerned.

Taking into account the multiplicity of variables and contexts, at the end each company proceeds to decisions in an individual way. Without neglecting this fact, LOGIQ investigated common patterns in the decision-making process of transport users. It was possible to identify similarities, not only in the decision patterns of companies studied, but also in the impact of decision patterns on the respective intermodal transport shares.

Three distinct groups of decision-makers and respectively three decision patterns have been identified as indicated in the following table:
<table>
<thead>
<tr>
<th>Decision-Making Process</th>
<th>Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision pattern components</td>
<td>Cost Oriented Group</td>
</tr>
<tr>
<td>Key factors</td>
<td>?? Cost</td>
</tr>
<tr>
<td></td>
<td>?? Reliability-Flexibility-Safety in an integrated way</td>
</tr>
<tr>
<td></td>
<td>?? Frequency-operating systems</td>
</tr>
<tr>
<td>Group size</td>
<td>35% of the sample</td>
</tr>
<tr>
<td>Intermodal transport usage: range of individual intermodal transport shares</td>
<td>50% - 100% Intensive users Significant market potential</td>
</tr>
</tbody>
</table>

The “cost oriented” group considers that the performance of intermodal transport meets its minimum requirements. For this group, the quality standards are “given” and any negotiation for using intermodal transport focuses on price. In addition, this group considers that the quality performance of intermodal transport operators can be “forced” through the negotiation on price. An eventual increase of intermodal transport prices would dramatically shift volumes from intermodal to door-to-door road transport.

The decision pattern of the “quality-cost oriented” group considers the criteria of reliability, safety and flexibility in an integrated way. In addition, these quality criteria, which derive from their own requirements, are associated with the respective criteria from the supply side: frequency of services, operating systems, information systems offered. Thus, in the case the criteria of flexibility and reliability are of high importance, the criteria of high frequency of services and supply of information systems take similarly high importance in the decision-making process.

The decision pattern of the “cost-quality oriented” group strongly inter-relates quality criteria with cost. This group has a “longer term” or “global” vision of operations of distribution channels and very often translates the quality performance in terms of cost. For example, an increase in speed allows a better turn of the equipment, higher frequency of services allows a better use of warehouses, higher safety leads to lower cost of insurance etc.

The “specific” group follows a decision pattern based on criteria of “specific”, not representative environments of operations. Issues of transport policy at European, regional and/or local levels determine the final choice of users. The supply of additional logistics services affects the final choice of users. This group largely outsources logistics activities, since it operates to a large extent small or irregular traffic volumes on the relevant corridors. Moreover, this group attributes high importance to the factor of historical tradition. The decision pattern of the specific group refers to particular characteristics of intermodal transport supply, which relatively differentiate from the common general characteristics of development of the other decision patterns. In one case out of five, the criteria governing the decision-making process can be neither generalised nor valid everywhere.
The larger group of decision-makers users of intermodal transport is the “quality-cost oriented” group, representing 45% of the sample. The “cost oriented” group is also of a major importance, representing approximately 35% of the total sample. The “specific” group represents approximately 20% of the total sample.

Statistically accepted correlation between generic groups of decision-makers and professional categories has not been proved. However, some trends have been identified. Shipping lines are mainly represented in the “cost oriented” group and forwarders belong to a large extent to the “cost-quality oriented” group. Moreover, it has been proved that the three decision patterns are not related to commodity types. They are also spatially dispersed within the territory of the European Union.

A small number of actors are exclusively intermodal transport users. Almost all the actors included in the three groups of decision-makers share their total volumes of continental traffic between intermodal and door-to-door road transport. Since three distinct decision patterns -with different priorities- refer to a given context of intermodal services supply, they result in distinct ranges of individual intermodal transport shares of actors.

LOGIQ Consortium also emphasised that there is a strong correlation between cost and quality (in particular speed/flexibility and reliability), in fact very often intermodal customer are able to translate the quality improvements of intermodal services into cost savings. In fact if the transport operator is able to reduce the lead time from A/C to A/B the shipper will be able to organised his transport three time a week instead of just two times a week; the consequence is that the transport operator is able to improve the volumes.

LOGIQ Consortium underlined the importance of price to gain a customer and the quality to maintain the customer, because the transport operator will always loose his clients if the quality of the service is bad perceived by the customer even if he is able to offer the cheapest price.

The ranges of individual intermodal shares are ranked. The “cost oriented” group range from 50% to 100% of individual traffic volumes. The shares of the “quality-cost oriented” group range from 10% to 50% of individual traffic volumes. Finally, the shares of the “specific” group range from 0% to 10%. The disposition of individual shares of intermodal transport is ranked, without overlaps.

The results of LOGIQ offer a new analytical tool to the European and national transport policy makers. Considering the three distinct groups of decision-makers and the respective decision patterns, the policy makers may investigate in the near future specific measures and actions for promoting intermodal transport. For targeting the potential of the “cost oriented” group, an investigation of possible new policy developments may be needed. The policy initiatives targeting this group should essentially focus on pricing issues and specify economic instruments for improving the competitive position of intermodal transport in the market. The necessary policy actions in order to take advantage of the potential of the “cost-quality” oriented group must focus on technical, operational and other factors, which might influence the quality performance.

The results of LOGIQ project enable to have interesting input for the analysis of cost structure and in particular useful results could come from the analysis of the following items carried out:

?? inter-relationship among actors involved in intermodal transport chains;
?? analogies in intermodal decision situations;
?? identification of decision makers for intermodal transport;
?? representative decision situation of reference;
?? intermodal market segmentation according to most important criteria in the decision making process.
5.6. **DSS – Decision Support System for intermodal transport**

5.6.1 *Introduction*

The variable and criteria found and evaluated in the second phase has been systematized in order to develop a modelling procedure of the decision making process. The result has been a model procedure that take in account the types of actors and their inter-relationship, the influencing variables and their weights, as well as the market segments.

The LOGIQ-DSS (Decision-Support System for Intermodal Transport) is a computer software for the implementation of the decision-making conceptual model,

This DSS can aid users to examine the advantages of intermodal transport and investigate scenarios of investments in infrastructure and equipment as well as improvements in operations and provision of services, in order to increase their intermodal transport share.

The main objective of the LOGIQ-DSS is to inform decision-makers about the parameters influencing the share of intermodal transport and to assist them in making the right choices in order to increase the use of intermodal transport by a specified user group.

Partial objectives include:

- a software implementation of the LOGIQ model
- a database of questionnaire results
- a quantification of decisive factors for intermodal transport

Since there are all kinds of models, simple and complex, but mostly rather sophisticated for an outside user to understand all their intricacies, the DSS research aims to provide a set of tools for making those models widely available, yet in a controlled manner.

The value-added of the DSS is that it provides a medium for bringing together all kinds of transport models and databases, making them available to a wider audience, and, in a user-friendly environment.

Potential users of the DSS are:

a) organisations/ companies interested to know how the changes (or those of their competitors) in their preferences and/or performances related to certain issues (variables) are affecting their decisions, and how those changes could influence the shift in mode choice in favour of intermodal transport by them (or by their competitors);

b) authorities (public or private) aiming at improving the existing infrastructure (rail, ports, freight terminals) in order to increase the traffic using intermodal transport, and so they could use the DSS to estimate if it is worth making the investment or not.

The LOGIQ-DSS is designed for non-specialist users that do not necessarily know all the intricacies of each and every model embedded in the DSS, but they want to ask specific questions within the range covered by one or more models. They are the non-computer experts. This is a category for which a user-friendly interface is required, and it consists of a variety of users ranging from a Decision-maker (even high in the hierarchy) to a Transport operator or consultant.

The LOGIQ-DSS has been developed using a set of software languages and tools. The most suitable development tool/language was selected for each one of the different DSS components, as follows.
**MS Visual Basic 6.0 object-oriented development environment**

Used for development of the main DSS program, database programming, application calls, and presentational (graph) utilities.

**Microsoft Office 97**

It is the "default" LOGIQ-DSS application environment. In particular Excel 97 and ACCESS were used for database applications and testing of the models. In addition relational databases for data storage and retrieval (MS Access) are used.

The present deliverable 3 comprises the theoretical presentation of the Conceptual Model for Decision making in Intermodal Transport and the software tool (LOGIQ-DSS).

Also, Deliverable 3 provides the User Manual of the software tool, giving the procedures for the installation, and how to run, as well as what are required inputs and the resulting outputs. The inputs and outputs are provided also with the corresponding screen shots as they generated by the software tool.

Finally, attached to the Final Report a CD-ROM with the software is provided.

### 5.6.2 Theoretical background of the LOGIQ – DSS

The DSS is an implementation of the second phase results of the LOGIQ research programme. The Framework simulates the impact of possible changes in supply characteristics on of intermodal transport to its usage (share of intermodal volumes to total volumes of the company transported by all transport means), according to the company decision-maker preferences related these characteristics. The adopted approach is based on the *supply side*. The developed model consider the preferences and changes of characteristics of the intermodal transport supply dynamic, and as such are not considered any more as "given". Hence, the impact of hypothetical changes in various supply characteristics is examined.

Nevertheless, the objective is not to develop a mathematical model for estimating the percentage of intermodal transport on “modal split” basis, as several models are doing. The elaborated tool comes in the form of DSS, which utilises the equations elaborated in the second phase in order to:

- determine those variables that mostly affect market share
- optimise, in cost terms, the variables that determine market share
- allow to examine (1) and (2) over a database of intermodal customers.

#### Classification of actor groups

The identification of actor groups having common decision patterns as far as intermodal transport use is concerned, has been based on qualitative data collected from the survey and essentially related to demand characteristics.

The mathematical expressions of actors’ decision patterns provide indirectly the physical meaning of sensitivity of decision patterns in the possible changes of intermodal transport supply. Since the three found key decision patterns differ, each actor group is separately examined. Three actor groups are identified: *Cost oriented*, *Quality-cost oriented*, and *Specific*. Needless to say that for all groups costs are of paramount importance. More specifically in the cost related group the only parameter that really matters are costs. These are reflected in the organisation of the DSS around the three actor groups identified.

The resulting models determine the relationship that associates the values of all quantitative variables to a single value of percentage of intermodal transport. Each model structures the
decision-making process of each generic actor group.

**Cost oriented group**

If a decision-maker belongs to the “cost oriented” group, its intermodal transport share $Y_{1i}$, can be estimated by the equation:

$$Y_{1i} = 83,2 + 4,2X_{1i} X_{8i} - 3X_{2i} X_{3i} + 1,2 X_{3i} X_{4i} - 1,1 X_{5i} X_{6i} + 1,7 X_{2i} X_{6i} - 0,2X_{6i} X_{7i}$$

The independent variables (some of which are generic, consisting of combinations of observed variables) of the equation are:

- $X_1$: Cost difference (% difference from the corresponding road transport cost)
- $X_2$: Reliability 1 (measured as delay in hours)
- $X_3$: Safety (max number of damages in the total number of transport operations)
- $X_4$: Flexibility 1 (1: if Flexibility affects the decision, 0: if Flexibility does not affect the decision)
- $X_5$: Flexibility 2 (time span between order entry and moment of departure, in hours)
- $X_6$: Regularity (0: for regular shipments, 1: for quite regular shipments, 2: for irregular shipments)
- $X_7$: Usage of intermodal (for how long the user has been using intermodal transport, in number of years)
- $X_8$: Contract duration (in number of years)

$R^2$ is considerably good (84%) given the small sample size.

**Quality-cost oriented group**

If an actor $i$ belongs to the “quality-cost oriented” group, its intermodal transport share $Y_{2i}$, is estimated by the following equation:

$$Y_{2i} = 29,8 - 426,1Q_{11} Q_{31} - 2,9Q_{21} + 91,3Q_{61} Q_{81} - 3,4Q_{51} Q_{71} + 0,4Q_{41} Q_{51} + 176008,9Q_{31} Q_{81} - 23,3$$

The independent variables (some of which are generic, consisting of combinations of observed variables) of the equation are:

- $Q_1$: Frequency of intermodal transport services (in days/week)
- $Q_2$: Reliability 1 (delay in hours)
- $Q_3$: Safety (max number of damages in the total number of transport operations)
- $Q_4$: Flexibility 1 (1: if Flexibility affects the decision, 0: if Flexibility does not affect the decision)
- $Q_5$: Flexibility 2 (time span between order entry and moment of departure, in hours)
- $Q_6$: Reliability 2 (% of delays in the total number of transport orders)
- $Q_7$: Frequency (1, if frequency of services allows for the use of intermodal, or 0, if frequency of services does not allow for the use of intermodal)
- $Q_8$: Commodity types (0 for general cargo of low value, 1 for the other commodity types)
- $Q_9$: First contact (1 if the intermodal transport operator first contacted the user, 2 if the user first contacted the intermodal transport operator)
- $Q_{10}$: Ownership of intermodal transport assets (1 if the user owns assets, 0 if the user does not own assets).
- $Q_{11}$: Reliability 3 (1 if Reliability affects the decision, 0 if Reliability does not affect the decision)

$R^2$ is considerably good (89%) given the small sample size.

**Specific group**

If an actor $i$ belongs to the “specific” group, its intermodal transport share $Y_{3i}$, is estimated by the
following equation:

\[ Y_{3i} = -1.2 + 3 S_{1i} S_{3i} + 0.9 S_{2i} S_{4i} \]

The independent variables (some of which are generic, consisting of combinations of observed variables) of the equation are:

- \( S_1 \): Reliability 3 (1 if Reliability affects the decision, 0 if Reliability does not affect the decision)
- \( S_2 \): Contract duration (in number of years)
- \( S_3 \): Change of intermodal transport partner (1 if yes, 2 if no)
- \( S_4 \): Use of intermodal transport for exceptional/unprogrammed shipments (1 if yes, 0 if no).

\( R^2 \) is considerably good (97%).

**Decision patterns and scenarios development**

The three equations simulating the decision making process for the three groups of actors/Decision Makers can be applied for testing the impact of any scenario (hypothesis) for intermodal transport performance and cost on the choice of mode by the Decision Makers (DM) in favour of intermodal transport, according to the group that the DM belong.

The development of these scenarios is a major objective of the third phase of LOGIQ. On the basis of the above presented models, the developed Decision Support System for Intermodal transport (LOGIQ-DSS) is able to elaborate scenarios and estimate the respective impact on intermodal transport choice by the DM, that affect the share of intermodal transport to the total traffic volumes of the company.

The use of the Decision Support System will allow testing various quantitative values of variables affecting the decision-making process and evaluate the sensitivity of results, in relation to these variables. It will also allow identifying for actors the conditions of shifting to the intermodal range of another decision pattern.

The Decision Support System described herein, aims at contributing to the elaboration of transport policy scenarios and the promotion of intermodal transport.

**Intermodal Share Changes**

The change in the intermodal usage is estimated with the formula:

\[
\frac{SIT_n - SIT_o}{SIT_o}
\]

Where:
- \( SIT_n \) = share of intermodal transport for new conditions
- \( SIT_o \) = existing share of intermodal transport.

As for the share, it is estimated with the above-presented models.

**5.6.3 DSS Methodology**

The LOGIQ-DSS has been developed by following four steps, which have been described in detail in the second phase:

1. Questionnaire database creation
2. Factor analysis and Decision-Tree construction
3. Quantification of decisions - Discriminant analysis
4. DSS implementation of the above as a combination of an Access database (1) and a Visual Basic system (2)+(3)

Step 1 - Questionnaire database creation

Questionnaire original results are stored as an MS Access database table ("expert" base) with the following specifications:
- each response as a separate record
- each parameter as a database field
- analysis parameters as additional fields

New cases examined by the DSS are stored in a similar database table:
- each scenario (user case) as a separate record
- fields with user choices correspond to first table
- additional fields for DSS recommendations - results

The DSS can compare the second to the first table and make recommendations for improving modal share for the given case.

Step 2 - Factor Analysis - Decision Tree

A factor analysis of the questionnaire results has identified groups and sub-groups of factors in the questionnaire.
These groups have been organized in a decision-tree showing what kinds of parameters are used in each case to determine modal share.

Step 3 - Quantification of Decisions and the related parameters

Discriminant analysis performed on the questionnaire parameters indicated the significant relations among variables. The analysis also quantified (i.e., in a linear function) the relationship among variables. The various relationships correspond to existing or new groups in the decision tree. The above are implemented in a Visual Basic program in the DSS.

Step 4 - DSS implementation

The software has been implemented using state-of-the-art technologies:

- The MS Visual Basic 6.0 object-oriented development environment
- Relational databases for data storage and retrieval (MS Access)
- Genetic algorithms for optimization of market share functions

The DSS is a combination of an MS Access relational database with MS Visual Basic subroutines for the LOGIQ model.

The LOGIQ model is based on the three equations that resulted from the regression analysis of the questionnaire results.

\[ Y_i = a_iX_1 + b_iX_2 + c_iX_3 + d_iX_4 + e_iX_5 + f_iX_6 + g_iX_7 + h_iX_8 + k_i \]

for i = "Cost oriented", "Quality-Cost Oriented", and "Specific" groups;

Where:
- \( X_1 \) to \( X_8 \) variables, such as, frequency of intermodal transport (days/week), cost (% difference from road transport cost), reliability 1 (delay in hours), reliability 2 (% delays in total number of transport
orders), flexibility (time span between order-departure, hours), safety (max number of damages in total number of operations); and, a to k constant coefficients.

DSS application

The DSS can assist a user to identify ways for increasing the percentage of intermodal transport for the case at hand:
- by asking questions according to decision-tree groups
- a "virtual" case questionnaire is filled out by the DSS
- the "virtual" results are compared to the "expert" results
- differences from expert results indicate changes to be made for improving modal share
- for selected ranges (user-specified) parameters, e.g. cost, reliability, time, etc. the DSS indicates how much they can affect modal share, and which parameters to change by how much to maximize modal share.

DSS software components

The DSS software comprises three main components:

a) a decision-tree model
b) a database of variables and scenarios
c) presentation utilities (tables, graphs, charts)

The Decision-Tree Model is a Visual Basic implementation of the conceptual model that has been developed from the Work Package 2 elaboration of the project, as regards the factors affecting the use of different transport modes.

It comprises:

?? the variables affecting the decision of what transport mode, or route, or technology to use
?? a categorisation of the variables, such as:
   - economic (costs, etc.)
   - technical (availability, accessibility, ...)
   - system's quality performance (safety, reliability, travel time, ...)

?? a hierarchy of factors and variables
?? ways to estimate the value of such variables (based on the result's of the project field-survey)

Questions to which the DSS can answer

DSS is predominantly addressed to transport operators-intermodal service suppliers.
Intermodal transport customers can also use it, in order to support their negotiations with the transport services providers.

The DSS works in two directions:
?? from data on traffic volumes to performance data
?? from performance data to data on traffic volumes

The DSS gives the possibility to users to put their own data

Lastly, the DSS gives general information/ guidance based on the questionnaire results.

Examples of LOGIQ-DSS questions

In the following we give a guidance/ specification of Example questions a user may ask the DSS:
A. FROM PERFORMANCE DATA TO TRAFFIC DATA

1. A user wishes to investigate:
   - his (hers) total market share on a link, or
   - one specific customers’ share

2. Defines a link and the total traffic volume on this link.

3. Changes in their performance, on this connection:
   - reliability1: give values to the indicator R1
   - reliability2: give values to the indicator R2
   - flexibility: give values to the indicator F
   - safety: give values to the indicator S
   - cost

4. If the user is able to assess the relative importance of criteria of his (hers) customers, gives the
   composition of his customers on this connection, according to their priorities:
   - priority to cost criterion
   - priority to quality criteria (reliability etc)
   - specific criteria

5. If the user, does not know the composition of his customers then lets the DSS classify each
   customer based on the composition of the research sample. Then, provides information on how
   each performance parameter (reliability, flexibility, safety, cost) affects transport volume
   As a result, the change in percentage of intermodal transport volume of the operator is given by the
   DSS.

6. The same exercise can be applied to one particular customer, if it can be classified within the
   three actor groups. In such case the user specifies which is the actual intermodal traffic volume of
   the customer, on the yearly basis.

7. If known, provides the priority in the decision-making process of the customer.
   - priority to cost criterion
   - priority to quality criteria (reliability etc)
   - specific criteria

8. If not, the DSS classifies the customer.

9. The user provides the estimated change in volumes of this customer.
   - the DSS gives the difference in volumes
   - for changes in given performance parameter (e.g. reliability1, cost, etc) the DSS will give the
     difference in volumes

B. FROM TRAFFIC DATA TO PERFORMANCE DATA

10. A user wishes to investigate:
    - his (hers) total market share on a link, or
    - one specific customer’s share

11. If he is able to assess the relative importance of criteria of his customers, then he provides:
    - priority to cost criterion
    - priority to quality criteria (reliability etc)
    - specific criteria
12. If not the DSS keeps the composition of the research sample and lets the user make, the changes he wishes in order to increase his market share up to x%.

The DSS gives scenarios:
- scenario 1: Increase in R1 by. Increase in R2 by.
- scenario 2: similarly

The DSS recommends the best scenario (e.g., increase R1, decrease cost):

13. For a specific customer a similar procedure can be followed.

14. In this way, any user can examine the questionnaire results and get information on the general LOGIQ recommendations, through the DSS. Thus, the DSS gives recommendations:
- reduce cost (to retain customers)
- increase quality (to attract customers)
- etc.

The DSS shows % modal share for different customer groups
- graph of Cost-Quality-Specific groups vs. market share
- % market share of each group
- % market left for each group

5.6.4 Validation of DSS

The conceptual model has been validated in two different ways. Firstly, with the existing data from the surveys and secondly during the LOGIQ workshop, where the LOGIQ-DSS as well as the related case studies elaborated in the fourth and fifth phases were presented.

During the LOGIQ Workshop the participants have expressed their agreement with the overall concept of the conceptual model about the decision making process in intermodal transport and they have stressed the importance of the cost element (transport price) in every decision. They have pointed out that price attracts the customer (since all of them are promising approximately the same quality of service), but the non-compliance with the promised quality of service make them loose the client. Consequently, this has led to underline in the tool that cost is the parameter that has to be considered in any case, and the others are the ones that have to be offered.

During the workshop the LOGIQ-DSS concept was presented (the actual software was not operational yet), and it was well accepted by most of the participants. They stressed the correlation between cost and quality (as a measure for speed/flexibility and reliability). Hence they welcomed the distinction to the three groups, with the underlining hypothesis that price is always of a primary concern.

Moreover a validation survey conducted during the elaboration of Chemical sector case study has re-affirmed the concepts present at the model and LOGIQ-DSS: contacts with between shippers and logistic service provid ers have a long-term character, but the level of commitment towards using the logistic service provider is low. The partnership relations, who are established, are based on mutual understanding, satisfaction and trust, but not on formal detailed contracts. Many shippers and logistic service providers have annual (or more frequent) evaluations, in which performance and pricing are discussed.

In addition the survey has demonstrated that the shippers and logistic service providers in the chemical goods market are very obviously both costs and quality oriented (safety and reliability). This, of course, is very much related to the fact that the goods carried are dangerous, and unsafe transport would have severe consequences.

In contrast to other segments, frequency of services (or flexibility) is not very important. Another observation included in the conceptual model and LOGIQ-DSS which is validated, refers to the
“cost-quality oriented” group, who has a longer term vision of operation, in which performance is translated into cost terms

As for Rhine Corridor case study elaboration, the presentation and the discussion followed had confirmed most of the basic parameters included in the LOGIQ-DSS, especially the ones related to the specific group, who has the fewer parameters.

The software tool (LOGIQ-DSS) can aid users to examine the advantages of intermodal transport and investigate scenarios of investments in infrastructure and equipment as well as improvements in operations and provision of services, in order to increase their intermodal transport share.

The DSS is designed for users, who are not experts in computer software applications. The tool has to be installed once in their computer and then it is ready for use. It has the capability to store the outputs of each application, which enables the user to examine comparatively different scenarios. In addition it provides the function for the user to compare the costs incurred due to investments or introduction/improvement of a service and the expected benefits from their realisation.

The above tool, although complete in its presentation, can not be considered as able to respond to all possible situations and scenarios. Although it is robust in its structure, it lacks sufficient data (based only on the sample of the conducted interviews) to support all possible applications. In some cases, the models embedded in the LOGIQ-DSS do not demonstrate expected sensitivity to the inputs. For this reason, some of the conclusions/answers should be treated with caution. Recognising it, such outputs are provided with a warning flag.

Overall, the tool could assist the business developers within a company to decide whether to invest in intermodal transport (e.g. acquisition of new equipment, investments in terminals), offer a new service or improve an existing one. They can simulate the reaction of their clients and thus they could know before hand the success or failure of their measures.

On the other hand, it can assist the policy makers (at national governments, European Commission) in deciding which of the measures they can introduce or favour –indirectly- their implementation, were more appropriate in order to contribute to the objective of increasing the intermodal transport share in the total traffic volume.

5.7. Analysis of the decision making process in intermodal transport in the case of chemical products

5.7.1 Introduction

In LOGIQ project, two representative case studies are analysed, in order to evaluate better the results and, based on well determined content, to detect specific issues in the decision making process. The case studies concern one “sectorial” and one “territorial” market segments.

The fourth phase of LOGIQ “Chemical sector case study” is one of the two case studies while the other is the Rhine corridor that will be analysed in the fifth phase. The objectives are to identify the actors and their role in the decision-making process of chemical product transport, to analyse their interrelationships and to identify and evaluate the decision criteria in choosing transport solutions and in mode choice in particular.

The reason to study the chemical sector was based on three observations:
Chemical goods comprise a large share of the present intermodal transport demand. Intermodal transport carries a large share of the goods produced in the chemical industry. The large shippers in the industry regularly indicate their intentions to shift cargo from road to intermodal transport.

A high share of present intermodal transport is a product processed at a chemical industry. Also, compared to other sectors, a high share of the product flow in this industry is carried by intermodal transport. This situation is to a large extent due to the fact that the average distances covered in chemical product transport is high: the industry is competing on a European and even on a global scale. The diversity of the products in the industry is high.

5.7.2. Chemical sector regulation and self-regulation

A high share of the goods carried is dangerous. This causes that transport is subject to more intense regulation. Most dangerous goods regulation is developed by United Nations, and is implemented at national levels.

The UN-approach is mode-oriented: for each of the transport modes, regulation is developed. In intermodal chains one has to comply with regulation for each of the modes the chain is composed of. In practice this does not lead to major barriers of using intermodal transport, except in case maritime and overland modes are linked. Between maritime and overland transport different symbols and classifications of dangerous goods exist, through which placards at containers are to be changed at seaports and documents to be made compatible to the two systems. This causes delays (and costs) and is considered as a regulatory inefficiency by the actors.

The environmental regulation is of higher influence on the usage of intermodal transport. Some terminals have to face high investments before they can get a permit to handle or store substantial volumes of dangerous cargo. For example, staff has to be trained, fire equipment must be available at terminals, in some terminals special floors must be constructed to avoid drainage of dangerous liquids or complex disaster plans have to be drafted. These measures have their logic, but can be impedance to the development of intermodal transport for dangerous cargo, more than to the development of road transport.

The facts that environmental regulation is developed on national or even lower levels and that transport regulation is mode-specific, cause difficulties to transport operators, who want to set up international intermodal transport.

They operate in a market for specialists, but even these specialists have difficulties in coping with the diversity and often changing regulations. Examples were given, in which intermodal transport operators were forced by circumstances to chose between regulations to be violated.

Regulation sets the constraints, within which companies must act. Differences of regulation between countries or between modes may affect the propensity of using intermodal transport. This section is to highlight the relevance, regulation appears to have on mode choice.

A distinction can be made between direct and indirect influence of legal issues. Direct influence has to do with regulation, which causes concrete bottlenecks or which simply restricts the use of a specific mode. Indirect influence has to do with regulations that influence the price or quality, and consequently influence the relative attractiveness of the modes.

Examples of direct influence of regulation are not many. The principle of free choice between modes is generally accepted. Only for carriage of very specific dangerous goods (national) regulators have intervened in mode choice by a strict licencing policy. The German and Austrian Government have forbidden interregional transport of some of the dangerous goods by road, unless the shipper can prove that other modes are no realistic options. Also for cross-Channel transport,
mode choice is directly influenced by forbidding of dangerous goods in Chunnel transport, so shortsea and ferry transport are the only options for these goods.

Most rules and measures are of indirect influence, either intended or not. The following examples are to show how transport regulation can affect intermodality:

- Incoherent modal legislation can affect technical interoperability (weight / dimensions of load units). The consequence of lacking technical interoperability is that load units are utilised sub-optimally in at least one part of the intermodal chain. The deadweight of a road tank vehicle is lower than the total of deadweights of a truck, a tank container and a chassis. The consequence is that in single-mode road transport the latter can carry less cargo. (This inefficiency is more than compensated by the relief of maximum vehicle weight restrictions of road vehicles used in intermodal transport.)

- Incoherent modal legislation can lead to organisational barriers. Documents are not interchangeable between maritime and continental modes. A low level of compliance to obliged documentation in sea-borne transport of dangerous goods was observed, which is evidence for the extra administrative burden resulting from this. In intermodal chains, which include a maritime component, placards on containers have to be replaced at the seaport terminal, because the symbols used under IMO-regulation differ from those in overland transport. This could be a serious barrier for shifting cargo to intermodal shortsea services.

- The importance of the liability regime was already discussed in the first work package. The number of actors involved in an intermodal chain can easily go beyond 10 in international transport. The cause of damages to cargo or to the load units is not always easy to trace. Many checks of the condition of the load unit which are necessary before liability is transferred to the next actor in the chain are to avoid conflicts on the issue, but these checks are cost enhancing. It is either accepting higher risks of erroneously taking responsibility for damaged load units, or accepting costs and delay caused by additional checks. This issue is of importance in any intermodal chain, but even more in dangerous goods, because of the high potential damage these goods can do to the environment.

- The composition of individual liabilities causes that insurance costs in intermodal transport in practice are higher than in unimodal transport.

- Differences exist in the intensity of control and enforcement in dangerous goods transport. Since checks imply delays and potentially are cost enhancing, transporters try to find the “route of least resistance”. This is in the advantage of unimodal transport and of modes and routes, which are least hindered by such checks.

- EU-directives and national regulation require that actors involved in transportation of dangerous goods possess licences. To obtain these, personnel must be trained and skilled and companies must have safety advisors. This counts for all modes. Since intermodal transport must comply to legislation of each of the carrier modes involved and therefore all actors must have the specific qualifications. This is a barrier to enter into the market of dangerous goods transport in total. It could also affect the propensity of using intermodal transport, especially in low-volume flows, in which investments in qualified staff are less likely to pay. On the other hand in high-volume flows transport companies can economise on training costs by using a restricted number of qualified in pre- and endhaulage of intermodal flows in stead of deploying them in long-distance road haulage.

5.7.3 Environmental regulation and self regulation

To get a licence for dangerous goods cargo handling or storage, terminals must take measures, defined in environmental legislation. Often, local government is the authorising organisation for this. Types of required measures are:

- Managerial measures: staff-members must be qualified, safety managers must be appointed, regular training and instruction sessions must be arranged for and control and emergency
procedures must be developed. If the throughput of dangerous goods exceeds a certain level, local authorities may require in-depth safety studies and safety plans.

- Technical safety measures, like fire prevention equipment, usage of absorption and containment materials, gas detection services and emergency lighting.
- Measures in layout or construction of the terminal: storage areas often must be separated from areas in which many people walk around; in some countries special floors and/or separate sewage systems, are to be constructed.

Such measures are a barrier for small terminals to involve in dangerous goods transport, as well as for dangerous goods terminals to really expand this business. The environmental regulation is cost enhancing for terminals and hence for intermodal operation. A consequence is that possibilities of intermodal transport to be integrated in chemical industry’s distribution chains are reduced.

Chemical shippers have set up quality assessment systems (SQAS), by which they want to improve the performance (mainly safety) in the logistic chain. Assessments support the choice for a logistic service provider, will influence contract negotiations and will sometimes highlight the need for specific improvements or investments. In practice, the value of the assessment system is that communication between logistic companies and shippers is improved. SQAS does not seem to influence mode choice.

Many producers of chemicals have committed themselves to the so-called “Responsible Care Program”. The industry wants to reduce the negative environmental impact of production. Logistics is considered as part of the production chain by some, which means that logistic strategies are also to reduce environmental effects. The result of this is that chemical shippers are quite open to shifting cargo from road to intermodal, but the extend to which this leads to a mode shift in practice can be disputed.

The use of SQAS by shippers and logistic companies can affect the choice of the mode:

- In intermodal chains, assessments are more complex, because of the higher number of actors involved and of the several chain elements.
- Road hauliers up to now are more often SQAS assessed. Terminals and railway assessment schemes are developed more recently, and up to now these operators have not made much effort to improve control over operations through SQAS assessment. This is a competitive advantage to the road hauliers.

SQAS does not intend to support mode choice, but rather to improve performance of logistic partners. Mode discriminatory results, as mentioned above may emerge, but it does not inevitably lead to a change in mode choice.

A threat to intermodal transport is that, after evaluation and detection of imperfections in performance on safety or quality, shippers will force operators to improve their services. Quality improvements and quality control are more difficult to implement in intermodal chains in which many actors are involved. The division in responsibilities amongst the actors involved is unclear. Costs and benefits of service improvement therefore may be unevenly distributed over these actors.

### 5.7.4 Chemical sector case studies: the viewpoint of shippers

Shippers in the chemical industry operate in markets, which are international and highly competitive. For this reason, logistics is at the core of their strategies.

The base line to shippers is that transport is safe and reliable. Order lead time often is critical: the
company must be able to deliver its goods very soon after the order. This does not necessarily mean that transport speed should be high. Often chemical shippers set up systems in which they create storage near potential customers or more advanced logistic solutions, like floating stock solutions.

The cost of distribution in this competitive environment also is very critical. This does not mean that shippers just compare prices of different transport operators. Logistic cost is wider than just transport. E.g. intermodal transport could be a more expensive option if door-to-door transport of a single trip is considered, but due to the use of tank containers advantages in storage and quick access to remote regions can be achieved.

Shippers therefore create systems, and evaluate the possibility of incorporating intermodal transport into it, rather than making day to day decisions on mode choice.

The common practice is that transport and other logistic operations, in spite of their strategic importance, are contracted out to third parties. Chemical shippers do maintain a high level of control though, and are often very much involved in setting up or adjusting logistic solutions.

The reason for contracting third parties is that the return on investments in transport equipment is low and capital is used for their core activities.

The tendency is to contract out to large companies. In most segments of this market, the selected logistic companies operate on a European scale. Logistic companies need to have a high level of proven quality, which in practice means that operators must possess ISO certificates. They need to be able to find and work with intermodal solutions, which implicates that pure road based transport operators are not seriously considered. Such intermodal solutions may differ per situation, but given the high level of competition the logistic cost remains the decisive element.

The contacts with between shippers and logistic service providers have a long-term character, but the level of commitment towards using the logistic service provider is low. The partnership relations, which are established, are based on mutual understanding, satisfaction and trust, but not on formal detailed contracts. Many shippers and logistic service providers have annual (or more frequent) evaluations, in which performance and pricing are discussed.

5.7.5 Chemical sector case studies: the viewpoint of logistic companies

Logistic companies have no choice but to comply with requirements posed by the shippers. This means that the operators in the chemical market have pursued the strategy of expansion towards European scale, either by co-operation or by take-overs or joint ventures. Most of them offer high-quality services and have achieved or aim at achieving ISO-certification.

Logistic companies are responsible for investing in transport equipment suitable for intermodal (and for road) transport concepts. Some also invest in terminals and storage and cleaning facilities. Compared to other segments in the transport industry, the level of investment is high. Equipment is specialized and dedicated to the single purpose of storing or moving chemical goods. Moreover, personnel need to be highly qualified and regularly trained.

To set up intermodal solutions, often much time, and therefore cost, must be devoted. In direct road transport, such “transaction costs” are hardly existent. Only one actor is involved, so quality aspects are easy to predict and costs are easy to calculate. In intermodal chains, the logistic company must get commitments to performance and cost from each of the actors. Of course, this procedure is non-repetitive, but it only pays if the system can be used more often.

The degrees of freedom to logistic companies are limited, by strict legislation, by technical
requirements and by the high competitive pressure in the industry of their customers. Within these limits, competition is mainly driven by efficiency enhancement, e.g. in fleet management to optimize efficient use of transport equipment. In some situations specific advantages can be created by investing in information technology solutions, providing management information and tracking and tracing facilities for customers.

5.7.6 Chemical sector case studies: mode choice

Shippers, especially at industry level, have a positive attitude towards intermodal transport, but in general are not willing to hand in added value in terms of transport costs and quality. Initiatives and investments regarding the use and development of intermodal transport services are taken by transport operators, seeking to find optimal logistic solutions. These initiatives are supported by shippers, not in a financial way, but usually only by (often weak) commitments regarding future transport volumes.

In general both shippers and transport operators state that price is the most important factor in the decision process regarding intermodal transport. Prices of intermodal services could be 20% to 30% lower than pure road transport. These differences are mentioned on the corridor Germany/Benelux – Italy.

However, many specific factors influence price differences between intermodal transport and pure road transport. These factors differ per situation, e.g. related to the level of competition in the road transport market on the corridor, the balance in freight flows, the cost effect of the relief in weight restrictions and distances in pre or endhaulage. The following table shows the factors, which influence transport costs and therefore the decision process regarding modal choice.

*Table: Costs factors influencing modal choice*

<table>
<thead>
<tr>
<th>Description</th>
<th>Road</th>
<th>Intermodal</th>
</tr>
</thead>
<tbody>
<tr>
<td>44 ton in intermodal versus 40 tons in road transport</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Unbalanced transport flows</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>High cleaning costs</td>
<td>-/+</td>
<td>+</td>
</tr>
<tr>
<td>Lack of cleaning facilities</td>
<td>+</td>
<td>-/+</td>
</tr>
<tr>
<td>Short term storage facilities</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Transaction costs</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Long distance pre-haulage</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Driving bans</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Long distance transport</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Level of competition in road transport</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

++ = very favourable  + = favourable  -/+ = indifferent  - = negative  - - = highly negative

5.7.7 Validation of the analysis of the customer survey

The shippers and logistic service providers in the chemical goods market are very obviously both costs and quality oriented. High quality is a basic requirement and competition seems to be mainly on costs.

The quality aspects, which are most important to the customers in this segment are safety and reliability. The first aspect, of course, is very much related to the fact that the goods carried are dangerous, and unsafe transport would have severe consequences.
In contrast to other segments, frequency of services (or flexibility) is not very important. It appeared that intermodal transport was used even in very infrequent flows, in which the logistic service provider was willing to adapt his demand to the possibilities intermodal transport offered. Of course, in such a case the price advantage must be apparent.

The observation made in the second phase of the project that the “cost-quality oriented” group has a longer term vision of operation, in which performance is translated into cost terms is confirmed by the case studies in the chemical industry. E.g. high equipment utilisation gives the necessary cost advantages, but it can only be realised by high reliability and control.

This longer term perspective implies that asset management and asset ownership are very important in the decision process of logistic companies, which is in contrast with the conclusions of the first results of the field survey carried out in the second phase. Intermodal load units are owned by logistic companies. Using them in single mode road transport is quite inefficient and more costly than using tank trucks. Therefore, if investments in load units are made by logistic companies, they will be very eager on deploying them efficiently. The other side of the coin is that investment in a tank truck fleet will enhance the usage of their road transport and therefore block using intermodal transport.

Transport policy does have effects on using intermodal transport in this market. The relief of weight restrictions for road in intermodal chains appeared to be very important to costs and therefore in mode choice – or actually in investment decisions of logistic companies.

5.8. Analysis of the decision-making process in intermodal transport in the case of the Rhine corridor

5.8.1 Introduction

In the project, the Rhine corridor case study has a “geographical” problematic that makes it very specific compared to the “sectorial” LOGIQ Demonstration case which is very specific for two reasons:

1. A specific geographical context on a corridor where the decision making processes for using intermodal transport are highly determined by the existence of numerous and competitive barge services, additionally to rail intermodal services. The investigation on the decision making processes considers firstly the underlined criteria and constraints for using barge or using rail intermodal transport services.

2. A specific geographical context where the Rhine corridor is viewed as a strategic corridor in a TransEuropean network approach and where we analyse the decision making processes for rail-barge intermodal services connecting the Rhine corridor to other major European corridors, the Transalpine and Rhodanian corridors

Therefore, this chapter is structured in two mains parts.

 Perez in the part I of the report, the decision making processes for using rail and barge intermodal transport of the shipping lines, the shippers or their forwarders is analysed;

 Perez in the part II of the report, the decision making processes for rail-barge intermodal services connecting the Rhine corridor to the Transalpine or the Rhodanian corridors is analysed.

But the main result of this LOGIQ Rhine case study is to show the two aspects investigated are not artificially linked, as presented in the conclusion.
5.8.2 The decision making processes for using rail and barge intermodal transport

An in-depth analysis of the decision making processes for using rail or barge intermodal transport appears as a prerequisite for further investigation on rail-barge connection.

Because the supply of intermodal transport services on the Rhine corridors is highly characterised by the number of barge intermodal transport services, additionally to rail intermodal transport services and while, at present time and for technical, the barge intermodal transport services are not able to offer their services to the intermodal continental units -swap bodies and trailers-, the analysis focuses on the container market segment - the inland leg of overseas chains -.

The in-depth understanding of the issues related to the Merchant versus Carrier haulage decision making patterns, in particular the issues regarding the tariffs and the operating rules (pick-up/drop off at inland depot versus “round trip” from/to seaport terminals) appeared as particularly important when investigating on the decision processes for using intermodal transport.

The result of the interviews point out the decision process of the shippers-forwarders or the shipping lines-their agencies are complex, with number of explicating factors.

DECISION MAKING PROCESS FOR INLAND TRANSPORT OF MARITIME CONTAINERS

NUMEROUS AND INTERDEPENDANT CRITERIA

The results of interviews, validates the choices of LOGIQ second phase 5 variables, Cost, Frequency, Reliability, Flexibility and Safety, but it also points out the Transit Time as one key variable that might be added.

In the report, the results of the interviews carried out are presented in a hierarchised manner:
1. at first are considered the results as for the 5 variables highlighted in second phase of LOGIQ. A sixth variable is added, the Transit time, highlighted in interviews as one key discriminate variable for using intermodal transport;

2. secondly, the results of the interviews that allow an in-depth understanding of the key factors determining the 6 variables presented above are indicated;

3. thirdly, we present the result of the interviews that allow an in-depth understanding of the key factors determining the general decision making processes of the actors for the inland leg of their overseas transport:

**A HIERARCHISED PRESENTATION**

<table>
<thead>
<tr>
<th>WP2 VARIABLES</th>
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<tbody>
<tr>
<td>COST - FREQUENCY-RELIABILITY-FLEXIBILITY -SAFETY</td>
</tr>
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</table>

| THE TRANSIT TIME |

The following examples are presented:

1. Considering the COST variable, the Rhine corridor case study allows to precise the cost-based decision processes, differentiating the Equipment Logistic costs from the strict Transport costs;

2. Results of interviews on the Rhine corridor also introduce the TRANSIT TIME as one critical discriminate variable for choosing intermodal transport;

3. The Rhine Demonstration case allows point out the LOCATION where the container is made available / need to be returned and the TYPE of equipment as key components of variables such as COST and TRANSIT TIME.

5.8.3 The decision making processes for rail-barge intermodal services connecting the Rhine corridor to the Transalpine or the Rhodanian corridors

The objective of the Rhine corridor case study was not to investigate a new market but clearly emphasises on the analysis of the decision making process in such a specific geographical context and a particular focus is given to the Upper Rhine area since:

?? two prospects for rail-barge Transalpine - Rhine intermodal services involve the Basel river port: the AquaRail Transit PACT feasibility study; the ROMI project.

?? a Rhine-Rhone rail connection is evoked that critically concerns the river ports of Strasbourg,
Mulhouse-Ottmarscheim and Basel.

The Upper Rhine area is not only an area of fierce competition between rail and intermodal transport services on the Rhine corridor, but also an area of fierce competition between major European seaports. Choice among the European ports and efficiency of their intermodal servicing, is critical in the shippers and forwarders’ and in the shipping lines’ decision making processes.

LOGIQ approach differentiated:

- a situation where the co-operation between rail and barge operators would take the form of a complementarily between two offers;
- a situation where the co-operation between rail and barge operators would take the form of a real integration of rail and inland waterways for a trimodal intermodal transport chain.

The emergence of rail-barge intermodal services and of rail intermodal connections to the Rhine corridor is highly under the influence of “external” strategies: the railways companies strategies and the offensive or defensives strategies of the different seaports.

We point out that, at first, the competition is prevailing

1. The high competition on prices is pointed out not only when considering the parallel rail and barge services on the Rhine corridor servicing the seaports of Antwerp and Rotterdam or on the Rhone corridor servicing the seaport of Marseilles but also when considering the rail intermodal transport services to other ports in competition with Antwerp and Rotterdam.
2. At the local level, the competition is also revealed at the infrastructure and equipment level, when the intermodal facilities are often segregated.

Investigating on the decision processes for emergence of rail-barge services, LOGIQ considered a context where the rail and barge operators are more used to struggle to an evolution towards cooperation. A co-operation between rail and barge operators that could take the form of a complementarily between two offers, as presented at Strasbourg about the Cigogne Shuttle or at Lyon for the servicing of the Port of Marseilles but in both cases did not plenty succeed to capture new markets to the road transport and that the rail intermodal transport services transferred to rail some traffic already capture by the barge intermodal services.

In fact, analysing the role of the actors in this multi-actors environment that involves the barge operators, the rail-road operators, the inland river terminals and the maritime terminal/maritime port, the examples analysed show - at Strasbourg or at Lyon - that the complementarily between rail and barge intermodal transport services is at first favoured by the public inland terminal operator.

The inland river terminal operator needs to maximise the use of its facility, to increase its volume throughout. Additionally to an activity of inland container depot, highly relying on road transport, the inland river terminal is critically interested to ensure the development of its intermodal activity.

But overall, the analysis points out the river intermodal facilities become strategic locations in the fast evolution competition environment of the rail-road intermodal operators.

The role of the river intermodal container operators in the fast evolving competition environment of the rail-road intermodal operators must be emphasised.

For instance it was all the more important for the CNC and the port of Marseilles to get involved the river port (the Port Autonome of Marseilles is taking a participation to the capital of Lyon Terminal) that the Lyon Terminal was contacted by ERS or could offer its facility to other rail-road operators -

12 It was noted above, presenting the results of the interviews with shippers and shipping lines the cost differential between rail and barge service along the Rhine corridor is low (decreasing to 7.5%).
such as ICF -which would look for own facility at Lyon.

The choice of the Lyon Terminal as the “ advanced port ” of Marseilles appears more as the result of a strategic approach to block the entrance of northern port oriented operators, to take advantage of a symbolic location at centre of Lyon. From the strict operational point of view, the terminal of Venissieux would have been more convenient for the rail services.

From competition to co-operation : rail-barge intermodal transport services?

The concept of rail-barge intermodal transport services was highly promoted by the launching of the PACT Aqua Rail Transit feasibility study.

On the one hand the concept of rail-barge services proved, with the Kaolin chain experience at Strasbourg, its operational feasibility. But on the other hand the interviewees mentioned the difficulties to be overcome, referring main to the following criteria :

1. The cost efficiency of the rail-barge intermodal services is questioned : at the point of rail-barge connection there would in fact be 2 additional transhipment operations, because the rail-barge integration cannot be organised with a direct transfer between the modes. Moreover the high cost of rail traction on short distance is pointed out

2. The transit time in rail-barge intermodal transport services ;

3. The complex monitoring of a trimodal transport chain: most of the interviewees point out the complexity of such trimodal transport chain and question the reliability and the quality of the monitoring of the services.

The strategies of the railways companies and of competing seaports are taken into account when investigating the prospects for rail-barge services connecting the Rhine corridor to major Transalpine or Rhodanian corridors.

Investigating the rail-barge services in a multi-actors decision making environment, we have to take into account the fact that the emergence of rail-barge intermodal services and of rail intermodal connections to the Rhine corridor is highly under the influence of “external” strategies, in particular the railways companies strategies and the offensive or defensives strategies of the different maritime ports.

In a decision environment characterised by the pressure of intermodal services linking the competitor port of Antwerp and Rotterdam and the monopolistic situation of the CNC and the SNCF for their rail intermodal servicing, the port authorities and seaport actors develop pro-active attitude to push the development of intermodal services adapted to their demand criteria (push the CNC to provide terminal to terminal and not only door to door services since the decision makers are also forwarders and shippers ) and adapted to their strategic commercial interest ( taking their part of the financial and commercial risk to launch services)

Conclusion : in a complex “multi-actors” decision environment, “reactive” but also “proactive” strategies for a better adequation of the supply to changing criteria of the demand

As presented in the introduction, one main result of this LOGIQ Rhine Case study is to point out the two aspects investigated,

?? on the one hand the shippers, forwarders and shipping lines “individual” decision making process for using intermodal transport

?? on the other hand an investigation on the decision making environment for development of rail-barge intermodal services
are not artificially linked.

However the three examples presented in this Executive Summary as results of the interviews – cost – transit time – location and type of equipment- have also been chosen because the analysis stresses the key importance to be given to the location strategies of maritime actors.

The accessibility of the intermodal terminal is always a determining criteria in use of intermodal transport for both shippers or shipping lines.

A criteria more evoked in terms of cost by the shippers than in terms of location strategy. This strategic dimension however appears as for the shippers -the large industrials- but rather as the component of a market pressure on the railways through the opportunity to use of inland waterways.

At the opposite, one important result of the analysis is to stress is that the strategies for location of their inland depot are, for the shipping lines, explicitly driven by the intermodal characteristics of the facility: as far as possible the inland depot will be rail and inland waterways connected.

This at a time when the inland intermodal terminals are given a new roles organisation of inland transport of maritime container : “inland hub” or “advanced port”

• Inland Hub

Traditionally the shipping lines do not want that the shippers or forwarders have access to their inland container depot, because it would mean that they take in charge the cost of the empty repositioning to the sea port : an empty repositioning from an inland depot that has no other function than standing storage before choosing the less costly solution for repositioning to the seaport.

But, as a response to the not favourable conclusions of the Multimodal Group and DGIV conclusion, the Conferences introduce a new concept for inland transport, based on the use of intermodal transport.

The concept of “hub&spoke” in inland container transportation is the consolidation of empty equipment at the level of large alliances or of conferences such as the TACA (which controls 60 to 70% of the transatlantic traffic) or of the FECE that controls up to 85% of the Europe-Far East market. In this system, the traffic between the seaport and the inland hub being transported either by barge or by rail intermodal transport.

At stake for the shipping lines it is the consolidation of container traffic and the increased possibility for re-employment of the containers. A process which in the majority of the cases allows a reduction of the prices by 15 to 20% compared to traditional carrier haulage and which allows the shipping lines to open access of the inland hub also to the merchant haulage.

At stake for the intermodal terminal, it becomes to change from a simple role of container depot and local distribution terminal to a role of key node in the maritime networks, with strategic logistics and commercial functions.

• “ Pre-port ” or “ Advanced port ”

The concept of the “pre-port” or “advanced port” is developed for instance by ECT when taking interest at Duisbourg or by the port of Marseilles when organising rail shuttle services between Fos and the Port Edouard Herriot container terminal at Lyon.
With these concepts, the intermodal connection exert a major impact on the competitive position of the inland terminals as strategic load centre. But it must be noted that the interviewed barge operator do not expect the development of an “main-port” concept on the Rhine corridor. None of the container terminals along the Rhine serves as an inland hub for other river ports.

The concentration of the container traffic in some Rhine terminals is not expected to result from river-linked hub formation. It rather reflects the differences in demand for inland transport in the immediate hinterland of the respective inland terminals and the land-oriented hinterland penetration of the inland port by other transport services.

At stakes for the river port is then the intensification and optimisation of the rail-barge transfer function of inland container terminals, that would exert a major impact on the competitive position as strategic load centre.

A strategic consolidation role that would be reinforced by an articulation with the rail intermodal transport system for an “redundancy” by the linking different seaports. Connections to several seaports that not only is a guarantee of reliability for the shipping lines, but moreover opens new possibilities for increased consolidation and reemployment of empty equipment.

These approach appears all the more important to introduce that one result of the LOGIQ Rhine corridor investigation is to point out that, for use of intermodal transport, the decision patterns of the shipping lines and of the shippers-forwarders are not independent.

Investigating firstly on the decision making processes for using rail or barge intermodal transport service on the Rhine corridor and investigating secondly on the potentials for rail-barge intermodal services connecting the Rhine corridor to major European corridors, the LOGIQ Rhine corridor demonstration points out that the research of a better adequation between the supply and the demand criteria has to be consider at two levels:

?? at a first level of the analysis, the cost, the transit time and the reliability are validated as critical factors in the decision making processes of the “final users”. These factors being pointed as the key variables to be taken into account in “reactive” strategies of the intermodal transport operators.

?? a second level of the analysis stresses the underlined criteria and constraints of the “final user” in their decision making process to use intermodal transport can be modified. In particular the strategies of the maritime and seaport actors are to be taken into account in “proactive” strategies of the intermodal transport operators.

The prospect for rail-barge services validates the cost, the transit time and the reliability as key variables for “reactive” strategies of the intermodal operator. The different actors from the demand-side interviewed in this LOGIQ Rhine corridor study, shippers, forwarders and shipping lines, did not always give precise responses when questioned about the rail-barge connection. Their approaches are pragmatic and it is mostly difficult for them to give appreciation about services that hardly exist.

However the elements of their responses validate the results presented in the PART I of the report regarding their criteria for use of the existing rail or barge intermodal transport service on the Rhine corridor.

About rail-barge intermodal services, the interviewees point out:
- at first the cost, emphasising on cost of the rail haul on shorter distance and of the additional transshipment operations at the interface between rail and barge,
- then the transit time,
- and finally the complexity of trimodal transport chains at which are linked qualitative factors, in
particular the reliability and the information monitoring.

Considering the research of a better adequation between the supply and the demand, such result points out this three variables as critical within “reactive” strategies of the intermodal transport operators.

The concept rail-barge intermodal transport is rather compared to the rail intermodal services than to the road alternatives.

Furthermore, it is particularly worth noting that the actors, when they consider the differential of cost and quality of such a trimodal transport service compared it to a rail-road intermodal transport chain rather than to a road alternative.

The concept of a rail-barge intermodal transport is considered by the interviewed actors at first as a competition between intermodal transport chain, more than as an alternative allowing emergence of new markets.

The punctual experience of the Kaolin transport chain through Strasbourg and the ART feasibility study seems to validate this appreciation.

The analysis points out the complexity of the decision process involving actors which interest are not always convergent.

Investigating on the rail-barge intermodal service, the LOGIQ Rhine corridor demonstration case stress not only the complexity of the decision making process for using intermodal transport but also the complexity of their decision making environment where the interests of the actors, either from the demand or from the supply side are not always convergent.

It points out the stakes to consider also the decision makers in their proactive strategies regarding intermodal transport, particularly the strategies of the seaport actors and shipping lines, that push the evolution of the supply while modifying the criteria of the demand, as illustrated by:

- the reduction of the number of inland depots, the consolidation of their equipment at few strategic location given a role of “inland hub” by conferences, large shipping lines and groups of shipping lines;
- the development of the “advanced port” concept by the port of Marseilles at Lyon or by ECT at Duisbourg.

Especially for the maritime and seaport actors, it is critical to consider that their use of intermodal transport is much more that a modal choice. It is becoming a critical component of their operating and commercial strategies that can result in restructuring the intermodal transport network and sector.

But the investigation also point out this dynamic process can be jeopardised by reactions of actors of diverging interests.

For instance, about rail-barge services it was pointed out during the interviews:

- the rail connections to the Rhine corridor are under the high scrutiny of the French harbours;
- the Rhine-Transalpine connection project of the BLS is under the high scrutiny of the national railways operating the Transalpine corridor.

As a result we can point at that at stake it is either the situation remains blocked, preventing the emergence of new services or the actors being able to innovated to overcome or by-pass the difficulties.

The stakes of such ability of the actors to push the suppliers for innovation can be for instance illustrated with the investigation of the Port of Strasbourg on rail-barge services targeting a
continental Germany-France market segment.

The Port Autonome of Strasbourg evokes the possibility to provide the German-Rhur area-France continental traffic with a rail-barge service. A rail-barge service at the Strasbourg river port as an alternative to road transport and as an alternative to hardly inexistent rail intermodal services. Rail connection and transhipment at the river port of Strasbourg would enable the shippers, forwarders and road transport companies to benefit from the flexibility and low cost of barge services on the German link, while the monitoring of a rail intermodal leg ending at the national border would be made easier and less expensive by the unicity of the railway company. This compared to a situation where the co-operation between the two national railways companies appears insufficient and when the IQ research project stress the shortage of rail intermodal services between France and Germany.

Such a prospect of a rail-barge service involving only the SNCF could be considered, not only because of the transaction costs raised when multiplication of the number of actors, or because of easier monitoring of the quality of the rail services, but more generally because of the railways price formation mechanisms.

As pointed out in IQ, the number of railways partners is to be taken into account for the determination of the rail traction price: the more partners, the highest the price especially when some partners only have a small distance on their network.

At stake there is in this example the development of “proactive” strategies of intermodal transport operators for innovation accompanying the evolution of the demand, even raising access to new markets.

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13 As pointed out in IQ one of the challenge about the cost harmonisation is not only the harmonisation but that the rail infrastructure charging system implements, for the international traffic, the economical logic of the tariff in the rail transport, i.e. the implementation of digressive tariffs according to the distance and not, as at the present time, the addition of the tariffs of each network used.
6. Conclusions

The results of the LOGIQ project can help to identify actors in the decision-making process and to provide information on underlying criteria and constraints employed by them for using intermodal transport.

The better understanding of the decision-making process will assist in defining actions and developing policies in order to increase the share of European transport in the European territory.

LOGIQ extensive field survey allow to understand the relevance of cost and price factors according to the intermodal customers for choosing or not choosing intermodal transport. They also indicate what are the trade-offs between price and quality factors.

LOGIQ Consortium emphasised that the decision-making for using intermodal transport is a quite complicated process. In this process are involved companies’ characteristics, requirements, external factors and supply characteristics and also are inter-related. The attitude of actors towards intermodal transport results from both “objective” characteristics and individual perceptions.

Considering the three actor types (forwarders/road transport companies, shippers, shipping lines) in an integrated way, LOGIQ researches proved that, among the criteria examined:

1. **cost** is the most important criterion in the decision-making process;
2. **reliability** is the most important quality criterion;
3. **frequency of services offered** and **rail operating systems** used are the most important criteria considered from the supply side, essentially for meeting the actors’ requirements in reliability.

Flexibility has been proved as less important than the aforementioned criteria. This is explained by the fact that the regularity of shipments is considered as almost a prerequisite for using intermodal transport. The regular users of intermodal transport rarely present very short lead times and therefore, the time horizon available for planning transport operations does not need to be of a high degree of flexibility in most cases. Furthermore, it is shown that the size of shipment (volume per transport order) does not affect the decision-making process. Obviously, it is noticed that for the 100% of cases examined, transport order is more than one loading unit. In the case of shipments less than one loading unit, the impact of this variable on the intermodal share might be major.

Three distinct groups of decision-makers and respectively three decision patterns have been identified as indicated in the following table:
<table>
<thead>
<tr>
<th>Decision-Making Process</th>
<th>Cost Oriented Group</th>
<th>Quality Oriented Group</th>
<th>Specific Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision pattern components</td>
<td>?? Cost</td>
<td>?? Cost</td>
<td>?? Regional-local specificities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>?? Reliability-Flexibility-Safety in an integrated way</td>
<td>?? Additional logistics services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>?? Frequency-operating systems</td>
<td>?? Individual-not generalised perceptions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>?? Historical reasons</td>
</tr>
<tr>
<td>Key factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group size</td>
<td>35% of the sample</td>
<td>45% of the sample</td>
<td>20% of the sample</td>
</tr>
<tr>
<td>Intermodal transport usage: range of individual intermodal transport shares</td>
<td>50% - 100% Intensive users</td>
<td>10% - 50% Relatively important market potential</td>
<td>0% - 10%</td>
</tr>
</tbody>
</table>

Statistically accepted correlation between generic groups of decision-makers and professional categories has not been proved. However, some trends have been identified. Shipping lines are mainly represented in the “cost oriented” group and forwarders belong to a large extent to the “cost-quality oriented” group. Moreover, it has been proved that the three decision patterns are not related to commodity types. They are also spatially dispersed within the territory of the European Union.

LOGIQ Consortium also emphasised that there is a strong correlation between cost and quality (in particular speed/flexibility and reliability), in fact very often intermodal customer are able to translate the quality improvements of intermodal services into cost savings.

The variable and criteria found and evaluated in the second phase has been systematized in order to develop a modelling procedure of the decision making process. The result has been a model procedure (Decision Support System – DSS model) that takes in account the types of actors and their inter-relationship, the influencing variables and their weights, as well as the market segments.

LOGIQ –DSS tool could assist the business developers within a company to decide whether to invest in intermodal transport (e.g. acquisition of new equipment, investments in terminals) offer a new service or improve an existing one. On the other hand it can assist the policy makers (at national governments, European Commission) in deciding which of the measures they can introduce or favour indirectly their implementation, were more appropriate in order to contribute to the objective of increasing the intermodal transport share in the total traffic volume.

Two Chemical sector and Rhine Corridor case studies contributed to identify and evaluate the decision criteria in choosing transport solutions and in mode choice in particular in a very detail manner. The results of the Chemical sector case study indicated how the shipper in the chemical industry are focused on “optimodal” solutions, acknowledging the potential of intermodal transport from an economic as well as quality point of view and acknowledging possible future developments in the road transport market in the form of costs increases due to internalisation of external costs, congestion and environmental issues. Since transport and distribution services are contracted out in this market, transport operators seek for lasting “optimodal” solutions, which comply which price
and quality demands of shippers. Initiatives of transport operators are supported by shippers, not in terms of financial commitments but often by volume commitments.

In seeking optimodal solutions, given a certain level of quality in terms of transport time and reliability, price is the most important criterion. Price differences between intermodal transport and road transport depend on a wide variety of factors and differ per situation.

Transport policy does have effects on using intermodal transport in Chemical products market. The relief of weight restrictions for road in intermodal chains appeared to be very important to costs and therefore in mode choice or actually in investment decisions of logistic companies.

Investigating firstly on the decision making processes for using rail or barge intermodal transport service on the Rhine corridor and investigating secondly on the potentials for rail-barge intermodal services connecting the Rhine corridor to major European corridors, the LOGIQ Rhine corridor demonstration points out that the research of a better adequation between the supply and the demand criteria has to be consider at two levels:

- at a first level of the analysis, the cost, the transit time and the reliability are validated as critical factors in the decision making processes of the “final users”. These factors being pointed as the key variables to be taken into account in “reactive” strategies of the intermodal transport operators.

- a second level of the analysis stresses the underlined criteria and constraints of the “final user” in their decision making process to use intermodal transport can be modified. In particular the strategies of the maritime and seaport actors are to be taken into account in “proactive” strategies of the intermodal transport operators.

The results of LOGIQ offer a new analytical tool to the European and national transport policy makers. Considering the three distinct groups of decision-makers and the respective decision patterns, the policy makers may investigate in the near future specific measures and actions for promoting intermodal transport. For targeting the potential of the “cost oriented” group, an investigation of possible new policy developments may be needed. The policy initiatives targeting this group should essentially focus on pricing issues and specify economic instruments for improving the competitive position of intermodal transport in the market. The necessary policy actions in order to take advantage of the potential of the “cost-quality” oriented group must focus on technical, operational and other factors, which might influence the quality performance.

Finally, it has been shown that there is a room for improvement of the communication policy and marketing strategy of intermodal transport suppliers. Many shippers are not well informed about the existing intermodal transport services and the relevant prices and quality performance. Rational decisions in the transport market need more complete information on supply. The transport policy makers should develop specific actions and events for facilitating the diffusion of information related to the existing situation opportunities of intermodal transport.
7. Annexes

Deliverable 1 is made of a Synthesis report and 9 Annexes.

WP1 Synthesis Report "The fundamental variables which affect decisions concerning intermodal transport" by Gruppo CLAS.

Task 1.1 reports:
Report 1.1.1. The transport market variables affecting actors in the decision making by Systema.
Report 1.1.2 Infrastructural factors affecting the decision making process by Inrets.
Report 1.1.3 Plans of infrastructure improvements by Gruppo CLAS.
Report 1.1.4 Traffic flows in intermodal transport by NEA.

Task 1.2 reports:
Annexes of Report 1.2.
Report 1.2.2 Identification of representative chains by INRETS.

Task 1.3 reports:
Report 1.3.1 Institutional environment and legal issues by INRETS.
Report 1.3.2 European Policy measures and decisions. Effect on competition among actors in the intermodal transport network by Systema.
Report 1.3.3 Transport through the Alps: legal issues and institutional environment by Gruppo CLAS.

Deliverable 2 is made of Final report and 4 Annexes.

WP2 Final Report is titled "The decision making process in intermodal transport".

The annexes are the three different questionnaires used to interview forwarders/road hauliers, shippers and shipping lines and the executive summary.

Deliverable 3 is made of Final Report and 1 Annex

WP3 Final Report is titled "Decision Support System for intermodal transport".
The annex is a CD-ROM “Decision Support System”.

Deliverable 4 is made of Final report and 5 Annexes.

WP4 Final Report is titled “Analysis of the decision making process in intermodal transport in the case of chemical products" and the author is NEA with the contribution of Gruppo CLAS and TFK.

Annex 1 is titled “The European chemical industry in a world-wide perspective" and the author is NEA.
Annex 2 is titled “The legislative framework” and the author is NEA with the contribution of CEMAT.
Annex 3 is titled “Italian chemical sector case study” and the author is Gruppo CLAS.
Annex 4 is titled “German chemical sector case study” and the author is TFK.
Annex 5 is titled “Dutch chemical sector case study” and the author is TFK.
Deliverable 5 is made of the Final report and 4 Annexes.

WP5 Final Report is titled "Analysis of the decision making process in intermodal transport in the case of Rhine corridor" and the author is INRETS with the contribution of Gruppo CLAS, Cemat, Duss and NEA.

Annex 1 is titled “Analysis of the decision making process in intermodal transport in the case of Rhine corridor” and the author is INRETS.

Annex 2 is titled “Analysis of the decision-making process in intermodal transport in the case of the Rhine corridor. Rail/Inland waterways connections. Case study Duisburg” and the author is DUSS.

Annex 3 is titled “Analysis of the decision-making process in intermodal transport in the case of the Rhine corridor. Intermodal transport market evolution and the strategy of the railway companies” and the author is Gruppo CLAS with the contribution of Cemat.

Annex 4 is titled “Analysis of the decision-making process in intermodal transport in the case of the Rhine corridor. Basle case study” and the author is Gruppo CLAS.
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