SEVENTH FRAMEWORK PROGRAMME

THEME [7]

Theme Title: Transport (including Aeronautics)

SuperGreen

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0 Executive Summary

This document is Deliverable D2.2 of the SuperGreen project. It presents the Key Performance Indicators (KPIs) to be used in the analyses of transports that concern the EU area directly or indirectly. The KPIs could be used to search for measures that improve transports so that they meet with the sustainable development goals of the European Union. The KPIs are relevant to the different groups of stakeholders in supply chains and to all surface transport modes.

An extensive literature review has been carried out and many potential KPIs have been scrutinised before coming up with a selection. The chosen KPIs have been allocated to five main groups, as follows:

Efficiency, with KPIs on *absolute* and *relative unit costs*. Absolute unit costs are expressed in € per ton for the entire stretch from the origin to the destination and relative unit costs are expressed in € per ton-kilometre for the entire stretch.

Service Quality, with KPIs on *transport time*, *reliability*, *ICT applications*, *frequency of service*, *cargo security* and *cargo safety*. *Transport time* refers to the total time in hours, *reliability* is here expressed as the percentage of on-time deliveries. *ICT applications* are a little more complex to measure, but are here the weighted assessed result of four indicators, namely: availability of tracking services on nodes/links, integration & functionality of tracking services, availability of other ICT services on nodes/links, and integration & functionality of other ICT services. The *frequency of service* describes the number of shipments available per week for each individual transport solution. *Cargo security* is about damage due to unlawful acts such as thefts or roadside robbery. *Cargo safety* refers to incidents that result in the damage of goods transported.

Environmental Sustainability, with KPIs on *greenhouse gases* and *polluters*. The *greenhouse gases* or carbon footprint is here limited to the emissions of CO_2-equivalent. The unit is grams of CO_2 per ton-km. It is recognised that the *polluters* are many, but here three are chosen, namely Nitrogen Oxides: grams NOx per ton-km, Sulphur Oxides: grams SOx per ton-km and Particle Matter PM: grams $PM_{2.5}$ per ton-km.

Infrastructural Sufficiency, with KPIs on *congestion* and *bottlenecks*. Congestion is a cause of delay. Average delays should be assessed per transport solution. The KPI for *bottlenecks* is the assessed result of an inventory of different types of bottlenecks per transport solution, which are further divided into a few categories reflecting the seriousness of each type of bottleneck. The objective of this set of KPIs is to find major bottlenecks per transport mode within corridors and estimate the seriousness of these bottlenecks.

Social Issues, with KPIs on corridor *land use*, *safety* and noise. *Land use* is expressed by % of urban areas over total corridor area, and % of Natura 2000 areas over total corridor area. *Safety* here refers to the incident rate of accidents and/or fatalities. The unit is percent of total number of shipments. *Noise pollution* is commonly defined as the excessive or annoying degree of unwanted sound in a particular area. The acceptable noise level is set to 50 dB except for trains which is 55 dB. The unit for the KPI on noise is percent of the total distance that is exposed to noise levels above the 50/55 dB limit.

1 Introduction - Purpose of this document

The purpose of this document is to describe the work done in SuperGreen Work Package 2 under Task 2.2 "Definition of Benchmark Indicators and Methodology." Task 2.2 is the second task of Work Package 2, following selection of the SuperGreen corridors, which was the objective of Task 2.1 (see also Deliverable D2.1). The main objective of Task 2.2 is to define the Key Performance Indicators (KPIs) to be used in subsequent tasks of Work Package 2 for benchmarking the selected SuperGreen corridors.

Task 2.2 started on 15 March 2010 as planned and is concluded with this report. There were six partners involved in this task: IHS Fairplay (task leader), Norsk Marinteknisk Forskningsinstitutt (Marintek), Sito Ltd., Det norske Veritas (DNV), DB Schenker and the Norwegian Public Road Administration.

Section 2 of this report describes the objectives of the SuperGreen project, of Work Package 2 and of Task 2.2.

In Section 3, the methodology applied for Task 2.2 is described.

In Section 4, a literature review of earlier projects related to Task 2.2 is presented. These projects have been used as references in support of this task. In addition, a number of existing tools for the calculation of emissions and intermodal transport costs are briefly presented in this section.

Section 5 is devoted to a number of good/best practice cases in intermodal transport logistics, exhibiting features that need to be addressed by the KPIs to be defined later on in the task. These cases have been selected among those reported by earlier projects in the area of logistics.

Section 6 presents KPI experiences from other sectors of the society. Emphasis is placed on the work of international organisations addressing the current environmental challenges.

The KPIs and related issues identified in the preceding three sections form the basis for the selection of KPIs, which is the subject of Section 7. The selected KPIs are presented in a concise manner here, while some relevant supporting details are placed in Appendices at the end of the report. The section also contains a methodology proposed for using the selected KPIs in the corridor benchmarking exercise.

The conclusions reached up until this early stage of the project are presented in Section 8, together with suggestions for further work on the subject that need to be done in the framework of the forthcoming project activities.

It should be made clear that whereas Task 2.2 is concluded with this document, the material described herein (KPIs) is subject to amendment in later phases of this project, as forthcoming activities in other parts of the project may feed back into it. Among such activities one may mention the series of regional workshops, starting with the one held in Naples on October 19, 2010, and, more generally, Task 2.4 of the project, dealing with the benchmarking of the selected corridors. Other tasks of the project, which were ongoing at the time of writing of this report, such as for instance Task 2.3, may be relevant here as well. Meanwhile, feedback from AC members and other stakeholders on KPIs has been received after the initial discussions at the Helsinki workshop of June 28, 2010, at the Naples workshop (as per above) and at the AC meeting held in Brussels on October 26, 2010. Said feedback will be described in the context of deliverable D2.4 (version 1). So generally we expect to be able to add to the substance of the present document as we move along, to the extent this is judged as appropriate.

2 Objectives

2.1 Objectives of the SuperGreen project

The EU Commission's Freight Transport Logistics Action Plan[1] introduces a series of policy initiatives and a number of short to medium-term actions to improve efficiency and sustainability of freight transport in Europe. One of these actions is to define "Green transport corridors for freight." In this framework, the SuperGreen project, an acronym for the "Supporting EU's Freight Transport Logistics Action Plan in Green Corridors Issues" project, was launched.

The general objective of the SuperGreen project is to support the development of sustainable transport networks by fulfilling requirements covering environmental, technical, economical, social and spatial planning aspects.

The SuperGreen project is a coordination action. It has sufficient "reach" in the wide area of freight logistics, and it will actively contribute by giving input to ongoing and new projects so that resources are used most beneficially. The SuperGreen project will:

- Give overall support and recommendations on Green Corridors to EU's Freight Transport Logistics Action Plan.
- Conduct a programme of networking activities between stakeholders (public and private) and ongoing EU and other research and development projects to facilitate information exchange, research results dissemination, communication of best practices and technologies at a European, national, and regional scale, thus *adding value to ongoing programmes*.
- Provide a schematic for overall benchmarking of Green Corridors based on selected KPIs, also including social and spatial planning aspects.
- Deliver a series of short and medium-term studies addressing topics that are of importance to the further development of Green Corridors.
- Deliver policy recommendations at a European level for the further development of Green Corridors.
- Provide the Commission with recommendations concerning new calls for R&D proposals to support development of Green Corridors.

2.2 Objectives of Work Package 2 and Task 2.2

The objective of Work Package 2 (WP 2) is to determine the major development needs and possibilities for the greening of transport chains in selected transport corridors. It also provides information on Key Performance Indicators (KPIs) suitable for assessing the economic efficiency, social acceptance and environmental sustainability of green corridors. The work is based on indicators developed for monitoring the sustainable development goals of the European

[1] Communication from the Commission: COM (2007) 607 final – "Freight Transport Logistics Action Plan"

Union. WP 2 will utilise the work done and taking place in member states on supply chain accounting and reporting, as well as testing sustainable development indicators for spatial and social planning. They will describe the current situation, the sustainability, as well as the future development aspects of the transport corridors.

The main method for collecting this information is through surveys, information based on existing materials, and from well-structured workshops having clear objectives. This work package provides basic information concerning subsequent work packages.

This work package is expected to produce the following information:

- General description of the EU's potential Green Corridors: preliminary definition, describing and grouping the most relevant corridors according to transport volumes, transport modes, infrastructure and the average length of transport chains.
- Selection of most important corridors among those defined as part of TEN-T, given prioritised criteria, for further information acquisition.
- Defining and grouping the benchmark indicators (key performance indicators).
- Clarification of the general and specific corridor changes in operational and regulatory environment that may hinder or promote the green logistics improvements in selected corridors.
- Description of the state of selected corridors using the defined indicators from the greening of transport's point of view.
- Description of future aspects of the corridors.
- Grouping and assessing the corridors using the benchmark indicators.
- Description of the major bottlenecks against the greening of transport chains in selected corridors.
- Description of the most effective areas for improving sustainability of transport chains in selected corridors.
- Definition of the common development aspects for all transport corridors.

The objective of Task 2.2 is the definition of the most suitable KPIs for benchmarking freight transport corridors. They need to cover the environmental, technical, economical, social and spatial planning aspects of intermodal freight transport and should be able to reflect the success factors of logistics chains and corridors against the sustainable development goals of the European Union. KPIs aim to assist in obtaining a clear and analytical picture of the current state and the development needs in 'greening' transport chains along the selected SuperGreen corridors.

The KPIs will be grouped into a few main areas based on what they indicate. The selected ones should be representative of the group they belong to, thus providing a window on the bigger picture of the group values. Their values can be qualitative or quantitative depending on their nature.

All surface transport modes will be covered. The KPIs should be able to reflect the different interests of the various groups of stakeholders in supply chains including transport clients and cargo owners, transport companies, ports and terminal operators, other logistics companies and transport sector authorities.

The methodology to be applied for the use of the selected KPIs in benchmarking corridors is another objective of this task, although not explicitly mentioned in the project's Description of Work document. A first attempt towards this end will be made here.

3 Methodology

Benchmarking is a practice with varying degree of complexity depending on the object to be benchmarked and the purpose of this activity. Result benchmarking is simpler than process benchmarking. Process benchmarking within a company is simpler than process benchmarking in an environment of multiple actors. Process benchmarking in an environment of multiple actors is simpler when these actors are either only partners or only competitors. In an environment where some of the actors involved are natural competitors who nevertheless have to cooperate, as is the case in intermodal transport, benchmarking becomes a very complicated matter.

The challenge becomes greater when one moves from the level of a transport chain to the level of a corridor used by a number of different transport logistics chains designed and effected so as to meet the divert needs of a very large number of transport clients and cargo owners. The matter gets further complicated when it comes to benchmarking "green" transport corridors, which for the moment have not been sufficiently defined.

In view of these difficulties and given the nature of this project (Coordination and Support Action), the methodology adopted for this task has to have the following characteristics:

- be holistic in its approach, meaning that the needs of the subsequent tasks of the project should be taken into consideration,
- draw heavily on the results of and problems faced by previous studies and research projects,
- take advantage of direct input from stakeholders,
- be as simple as possible in its application, and
- be flexible in the sense that it should be easily adjusted to problems encountered during application.

In addition, the KPIs involved in the benchmarking process should exhibit certain characteristics:

- Preferably they should be quantitative, albeit in process-benchmarking, qualitative KPIs are often necessary.
- They should be comparable, allowing meaningful results.
- They should be useful, in the sense that the derived results can lead to improved performance.

The 20-step methodology described below has been selected as fulfilling these conditions:

Step 1: Review past studies and research projects assessing transport corridors or operations. Emphasis should be placed on methodological issues and indicators used. Identify critical factors affecting the outcome (success/failure) of these works. The extensive literature review foreseen under Task 2.3 (Effects of changes in operational & regulatory environment) can provide additional input in this regard. Given that this will not be available prior to completion of Task 2.2, any valuable additions can be included either in Deliverable 2.4 or in a revised version of the present report, depending on its extent.

Step 2: Identify success factors of transport chains and corridors considered as "best practice" cases. Check whether the indicators found in Step 1 can reflect these success factors.

Step 3: List experiences of KPIs in other sectors of the society. Emphasis should be placed on the work of international organisations addressing the current environmental challenges.

Step 4: Based on the findings of the previous three steps, compile an initial list of indicators. Make sure that the environmental, technical, economical, social and spatial planning aspects of intermodal freight transport are covered.

Step 5: Group indicators in a few main areas based on their nature.

Step 6: Select a small number of representative indicators from each group. They will comprise the initial list of KPIs. An internal workshop is the preferred method for this activity.

Step 7: For each KPI of the above list, describe the input values needed for its calculation and the exact formula to be used. Qualitative indicators should be kept to a minimum.

Step 8: Solicit feedback on the initial list of KPIs from stakeholders and the project's Advisory Committee.

Step 9: Revise the initial list to incorporate input received.

Step 10: Select one of the 9 SuperGreen corridors to be used as pilot case for testing the methodology. The corridor with the best coverage in terms of data availability and studies done should be selected.

Step 11: Analyze the corridor in terms of flows:

- origin/destination
- types of cargoes moved
- modes used
- routes taken
- trade imbalances (empties), etc.

The segment of the corridor with the highest freight volume is the most important part of it.

Step 12: Select 4-5 typical cargoes being transported along the axis. Part load break bulk should be one of them due to the special logistics requirements that this cargo imposes. Most probably, a dry bulk and a liquid bulk commodity should also be selected due to their high volume and different supply chain organization. For each cargo selected, identify a typical combination of modes/routes used. Identify also useful details like the types of vehicles used, technologies applied etc.

Step 13: Add to the typical cases selected above, the "best practice" cases identified for this corridor.

Step 14: Locate the proper data sources for estimating the KPIs defined under Step 9.

Step 15: Estimate one set of KPIs for each case selected under Steps 12 and 13. Due to the length of the selected SuperGreen corridors, it is very much probable to have segments with different "green" qualities along a single corridor. It is thus preferable to do the analysis in segments to the extent possible.

Step 16: Identify obstacles in KPI estimation. They can follow in one of the following categories:

(a) those that can be solved easily,
(b) those that require a new approach to solve them, and
(c) those that need to be defined as not solvable.

A KPI re-engineering process is to be followed for obstacles of categories (a) and (b). KPIs running into obstacles of category (c) should be dropped altogether.

It is conceivable at this stage that segments of the corridor for which sufficient data is not available can be dropped from further examination.

Step 17: Suggest a way to transform the KPI values estimated at the route level to a single set of KPI values at the corridor level.

Step 18: Suggest a way to express the set of KPI values derived under Step 17 above for the corridor level with a single numerical value, the ultimate corridor KPI.

Step 19: Once the methodology suggested above has passed the applicability test successfully, it can be applied for the other 8 SuperGreen corridors as well (repeat Steps 11 to 18 for each of the 8 corridors).

Step 20: Perform a comparative analysis of the 9 SuperGreen corridors and draw conclusions on developing the "green corridor" concept.

It is evident from the above plan of activities, that the final list of KPIs will not be produced prior to having them checked in practice (completion of Step 18). In this sense, Task 2.2, which is the subject of the present report, aims to produce the initial set of KPIs and their definitions (Steps 1 to 7).

The preliminary results of this task were presented during the first SuperGreen stakeholders' workshop organized in Helsinki, Finland on 28 June 2010 and were communicated to the members of the project's Advisory Committee together with other material. However, the issue of corridor selection was more central to stakeholders' interest during this event and not much feedback on KPIs was received at the time.

It is for this reason that the consortium has requested to bring forward the first of the regional workshops foreseen under Task 2.4, all of which were originally planned for the spring of 2011. Based on the results of this workshop (held on 19 October 2010 in Naples, Italy), and on further input by the project's Advisory Committee, the initial list of KPIs, as described in this deliverable, may be amended[2].

[2] Assessment of feedback on KPIs from the Naples workshop and from the AC meeting held in Brussels on Oct. 26, 2010 will be in deliverable D2.4 (version 1).

4 Literature review

The findings of the most relevant studies and research projects in terms of KPIs and their calculation method are summarized in this section. Benchmarking of intermodal transport chains is a core objective of the BE Logic project, which is reviewed in more detail than the rest of the documents due to its higher relevance to SuperGreen. In terms of modal transport, KPIs have been developed for benchmarking rail and shipping operations. The most recent projects in these areas are InteGRail and Shipping KPI respectively, which are also presented here. The section also covers the International Maritime Organisation's EEDI formula, which will soon apply to most new-built vessels.

The remaining of the section is devoted to existing and under development software tools that can be used in calculating KPIs. The NTM model, the EcoTransIT tool, a tool for calculating external costs in transport and a number of transport cost calculators are presented, albeit not formally assessed yet.

Although extensive, the literature review performed under this task cannot be considered as exhaustive. A review much wider in scope is under way within the framework of Task 2.3 and will be reported in Deliverable D2.3. Should interesting findings in terms of KPIs and their applications result from this effort, they will be either incorporated in other scheduled deliverables of the project, or a revised version of the present deliverable will be issued, depending on their extent.

4.1 The BE Logic project

4.1.1 Project identity

"BE Logic" is the acronym of the "Benchmark Logistics for Co-modality" collaborative project funded by the European Commission under the 7th Framework Programme. It is ongoing, as it started on 1 September 2008 and lasts for 2.5 years. There are 9 partners involved (ECORYS, ISL, D'APPOLONIA, NEWRAIL, MOBYCON, AUEB-PC, HERRY, VGTU and UIRR), led by ECORYS.

The project aims at improving efficiency within and across different modes of transport and supporting the development of a quality logistics system. This is done through the benchmarking of: (a) transport policy, (b) transport chains and (c) inland and sea terminals. The project will also develop and implement an e-benchmarking self-assessment tool, incorporating the benchmarking methodologies and the related KPIs. Targeted mainly at SMEs, this e-tool will be accessible on the Internet by all registered users, on a free of charge basis. In addition, the project will evaluate existing quality systems and requirements for the logistics sector.

The present review is based on the following reports available on 31 July 2010 at the project's site (http://www.be-logic.info/):

- Deliverable D1.1 – Project Plan (06-01-2009)
- Deliverable D2.1 – Overall Benchmarking Framework (10-06-2009)

- Deliverable D2.5 – Design and Development of the e-Benchmarking Tool (25-11-2009)
- Deliverable D3.1 – Analysis of the Impact of the External Environment, Supply Chain and Freight Transport Trends on the Performance of the Freight Transport System (25-09-2009)
- Deliverable D3.2 – Factors affecting Transport Logistics – Good Practices (11-06- 2009)
- Deliverable D7.1 – Existing Standards in Transport Logistics (20-10-2009)
- Deliverable D8.1 – Dissemination Programme (18-02-2010)

and the:

- R.Jorna and J.Bozuwa, "Benchmarking from different perspectives", presentation at the European Shippers Council, 20 May 2010, provided by BE Logic Coordinator Mr. Jeroen Bozuwa.

The text that follows incorporates to the extent possible the comments of Mr. J. Bozuwa, who kindly accepted to review a first draft of the present piece in an effort to make it as accurate as possible[3].

4.1.2 The methodological framework

The methodology part of BE Logic is comprehensive and insightful, and as such deserves special attention. An "overall benchmarking framework" is first developed so as to provide a common understanding on developing the methodologies for the policy, transport chain and terminal benchmarking, which is the main objective of the project.

A number of terms and conditions necessary for a benchmarking process are presented. The three most important of them are:

Firstly, benchmarking requires a clear definition and description of the entire process (e.g. aims, participants, indicators). On the other hand, it is a practical method that requires flexibility in its implementation. Therefore, the benchmarking methodology has the character of a permanent reengineering process adaptive to the given benchmarking surroundings.

Secondly, the questions that need to be answered prior to designing a successful benchmarking process are:

- Why the benchmarking is carried out?
- Which are the users who will carry it out?
- Which are the beneficiaries who will benefit from its results?
- Which are the processes that are to be benchmarked?
- Which information (KPIs) is required?
- Who will provide the data?

Thirdly, KPIs involved in the benchmarking process should exhibit certain characteristics:

- Preferably they should be quantifiable, meaning that they have to be assessed by certain units and have a numerical value for the respective unit. (However, in policy- and process-benchmarking, as opposed to result-benchmarking, qualitative KPIs are often necessary.)

[3] We take the opportunity to express our sincere gratitude to Mr. Jeroen Bozuwa for his assistance.

- They should be comparable, or in other words they have to be quantified in all occasions in the same way, allowing meaningful and significant results.
- They should be useful, in the sense that they should contribute to the ex ante defined aim of the benchmarking and that the derived results can lead to improved performances.
- The organization using the benchmarking results should be able to influence the KPIs in a favourable way; otherwise the learning benefit would be missing.

The framework methodology comprises the following six working steps:

1. A clear statement of the aim of the benchmarking process.
2. Planning phase involving the following actions:
   - identification and analysis of previous studies and projects concerning the individual tasks
   - identification and list of failures of previous studies/projects
   - definition of the benchmarking subject
   - description of expected results
   - identification of stakeholders to be involved into the benchmarking process
   - identification and description of the role of the final users
   - identification and description of the role of the final beneficiaries
   - description of the potential risks within the benchmarking process concerning failure of project results – but also concerning risks for users through e.g. non-comparable or unspecified data.
3. Identification phase involving the following actions:
   - definition of requirements that benchmarking indicators have to match for each relevant target group
   - categorization of benchmarking areas
   - identification of indicators that are to be benchmarked
   - definition of units and formulas for the calculation of values for the identified indicators
   - description of the source of information for the defined indicators
   - feasibility check concerning availability of quantitative or qualitative values for the indicators.
4. Collection phase, during which indicators take concrete values.
5. Analysis phase involving the following actions:
   - comparability check of results
   - evaluation of benefits that can be gained from the results
   - assessment of whether these benefits can influence the future performance of the actors concerned.
6. Quality control phase addressing potential problems that might occur in the previous phases and involving:
   - assessment of the risks and problems having occurred
   - development of a reengineering process to cope with solvable problems.

4.1.3 Policy benchmarking

The final report for this task is not currently available and our review is based on the relevant material of Deliverable D2.1 and input received from the coordinator of BE LOGIC (Jeroen Bozuwa).

The aim of the policy benchmark is to identify relevant policy framework conditions

- at EU-level
- at national level for selected Member States (AT, CZ, ES, DE, GB, GR, IT, LT, LV, NL, PL, RO) and Switzerland and
- for selected non European countries (US, Japan).

Benchmarking of transport logistics policies has been carried out at two different levels (in two separate tasks as described in the original Description of Work, Annex 1 to the contract of the BE LOGIC project, dated 7 March 2008):

1. Benchmark of national transport logistics policies in EU Member States: The logistics and intermodal related policy (framework) has been analyzed for the 13 selected countries mentioned above and an assessment of the compatibility of these policies with the relevant EU policy has been performed. The following aspects and issues have been considered (if relevant for all modes of transport): overall transport policy and planning, rail liberalization, infrastructure pricing, legislation, governmental aids, taxes, general performance indicators.
2. Benchmark of EU transport logistics policies against non-EU countries: The relevant EU transport logistics policies and programs and the development of the direction and focus in time have been benchmarked and compared with the same policies in other important countries, like the USA and Japan. Local experts in the USA and Japan have assisted in developing the benchmark in those countries.

Benchmark of national transport logistics policies in EU Member States

Via literature review and interviews with representatives of national authorities of different European countries, the following KPIs have been selected to compare the policy of the selected European countries:

- Overall transport policy and planning
  - Stakeholder integration
  - Regional responsibilities
  - Status of transport modes
  - Existence and status of transport (master) plans, modal split plans, CT-plans, security and safety plans
- Rail liberalization:
  - Separation of function
  - Market access
  - Safety
- Infrastructure pricing (per mode)
  - Pricing level
  - Type of pricing
  - Network coverage
- Legislation
  - Bans and regulations
  - Accessibility
  - Priority and train path allocation to rail freight and CT
- Governmental aids:

  - Monetary aids (existence and amount of funding schemes)
  - Infrastructure access (limitations, capacity, future development)
- Taxes (per mode)
  - Tax level
  - Type of taxes
- General performance indicators
  - Transport (performance per mode, share of CT)
  - Social (air pollution, green house gas, accidents per mode)
  - Economic (policy caused transport costs, value added of the transport sector)

Benchmark of EU transport logistics policies against non-EU countries

This part of the analysis comprises various comparative assessments:

1. Comparative assessment of the current policy status on transport logistics in the EU, USA, and Japan. This is performed on the basis of the following logistics and intermodal policies: i) Rail liberalization, ii) Infrastructure pricing, iii) Taxation policies, iv) Legislation regarding driving bans and authorized dimensions for Heavy Goods Vehicles (HGVs), and v) Governmental aid in relation to intermodality / co-modality.
2. Comparative analysis of the intended policy outcomes in the EU, USA and Japan. This analysis concerns the following policy objectives: i) Increase of competition both within a mode of transport and between the different modes, ii) Increase of the linkages of modes, iii) Efficiency improvements both on each transport mode and on the transport system as a whole, and iv) Increase of freight transport safety and security, and reduction of freight transport social and environmental impacts.
3. Comparative assessment of the evolution of policies affecting intermodal / co-modal transport and modal shift among the EU, USA, and Japan for 2020.

The main conclusion of the analysis is that different transport policies have different effects on the development of the transport system in Europe. Transport policies can “only” provide a framework. The transport system is influenced by external factors like the economic development of different sectors, the development of the labour market, the penetration of globalization etc.

Policy effects on the transport system can be measured by performance indicators like transport volumes (tonnes), transport performance (tonne-kilometres), emissions, accidents, value added of the transport sector. Through similar performance indicators, an assessment has been made (using own analysis and existing literature) as to what extent certain policy measures result in:

- better performance of the transport sector in economic terms (i.e. value added,) and
- better performance of combined transport (i.e. higher share of modes alternative to road).

The policy documents analysed for the 13 European countries and for USA and Japan present a lot of intended outcomes to be achieved in the near future. Due to numerous existing barriers, not all objectives will be achieved. Deliverable 4.3 of the BE Logic project identifies these barriers and links them to specific national policy intentions on competition, linkage of modes, efficiency, safety and security, social and environmental aspects.

4.1.4 Transport chain benchmarking

The final report for this task is not currently available either, and our review has to be confined to the relevant material of Deliverable D2.1. As this part of the BE Logic project is the one most closely related to the SuperGreen objectives, we will look at it in more detail.

Two points of the planning phase are worth mentioning:

Firstly, a number of failures of previous benchmarking studies and projects have been identified for avoidance, the most important of which are:

- Too many different indicators
- Data availability proves to be too low, requiring significant investments
- Companies are not willing to share information with other parties, especially concerning sensitive issues like "costs"
- Increased possibilities for confusions and mistakes if the input and output are not being presented in a clear way
- Keeping the benchmark up-to-date.

Secondly, the task focuses on transport chain companies that offer services over longer distances. "Longer" in this sense means a distance where intermodal transport could be considered as an alternative. It means at least inter-urban transport (thus excluding urban distribution) and also of sufficient length (>200 km). In terms of modes, pipelines and air cargo are not covered.

As for the KPIs (identification phase), they should be:

- easy to use
- measurable or having clear meaning to final users
- weighted (relative importance in comparison to other indicators)[4]
- grouped/fit within preconceived groups
- able to be looked upon in a top-down manner, resulting in KPI trees
- related to business or societal performance of a transport company
- able to be used directly or indirectly to achieve a competitive advantage for the company involved
- up-to-date and providing sufficient quality/richness of information
- relevant (there should be a clear link between indicators and objectives)
- comparable (quantified in all organizations in the same way)
- durable (be able to assess performance for at least 10 years)
- robust (resistant to manipulation by those responsible)
- easy to compute (required data should be easy to acquire/involve low cost)
- sensitive to the company's classified information
- mutually exclusive and collectively exhaustive.

The KPI selection process involves the following steps:

1. Extract currently known indicators from available studies/projects on logistics benchmarking
2. Add input from leading transport companies in terms of quality

[4] Depending on the role of the actors in the transport chain, the weight of the indicators might be different.

3. Add indicators based on recent developments in the transport sector
4. Validate the listed indicators on predetermined requirements
5. Check feasibility internally with project partners
6. Finalize first draft list and circulate it to stakeholders
7. Incorporate stakeholder input
8. Finalize indicator list with project partners
9. Implement the e-tool.

The KPIs suggested for transport chain benchmarking, as they resulted from the above process, are:

Time

- Door-to-door time, total time for the complete transport (days, hours, minutes)
  - Loading time (days, hours, minutes)
  - Driving/sailing time (days, hours, minutes)
  - Unloading time (days, hours, minutes)
  - Waiting time at borders, terminals, etc. (days, hours, minutes)

Costs

- Transport/tender costs, total costs involved in transporting the goods (€)
  - Vehicle/vessel costs e.g. rent, depreciation, maintenance (€/km)
  - Fuel/energy costs (€/km)
  - Infrastructure charges e.g. road tolls, rail charges, lock charges, etc. (€/km)
  - Cleaning costs making transport equipment ready for next shipment (€)
  - Delay costs incl. penalty fees, rent of equipment, personnel costs, etc. (€)
- Terminal/handling costs, total cost involved in handling the cargo (€)
  - Handling fee loading (€/container or other transport unit)
  - Handling fee unloading (€/container or other transport unit)
  - Terminal storage charges (€/container or other transport unit)
  - Container rent (€/container or other transport unit)
  - Inspection costs (€/container or other transport unit)
  - Insurance costs at the terminal (€/trip)
- Overhead costs e.g. booking, monitoring, invoicing, etc. (€/trip)
- Inventory costs (€)

Flexibility

- Capacity to be flexible, composite indicator (no units specified)
  - Ability to adapt to changes in demand/volume (scale 1-5)
  - Ability to adapt to changes in size / special cargo (scale 1-5)
  - Ability to adapt to changes in time table (time needed to return to normal conditions / response time)
  - Robustness, ability to cope with serious disruptions like cancellations, strikes, etc. (scale 1-5)
  - Availability, possibility to have custom made departure times (yes/no)

  - Availability of fixed time tables (number of departures per week)

Reliability

- Punctuality (% of consignments on time)
- Variation of transit time (maximum deviation as % of average transit time)
- Reputation (scale 1-5)
- Complaints (number of complaints per year)
- Cargo damage during transport or handling (% of trips per annum in which cargo was damaged)
- Cargo loss/theft during transport or handling (% of trips per annum in which cargo was lost/stolen)

Quality management

- Cargo tracking and tracing (scale 1-3)
- Terms of payment (number of days, the longer the better)
- Presence of quality system, ISO or other certification (yes/no)
- Documentation accuracy (scale 1-5)
  - Billing arrangements (error rate in bills of lading)
  - Invoicing accuracy (error rate in invoicing)
  - Proof of delivery – POD (time necessary to send a POD)
  - Confirmation of delivery – COD (time necessary to send a COD)
- Level of electronic communication, use of EDI (scale 1-5)

Sustainability

- Environmental gasses and air polluters, composite indicator (no units specified)
  - CO_2 emissions (kg of CO_2 per km/tonne/litre)
  - SO_2 emissions (gr of SO_2 per km/tonne/litre)
  - $PM_{2.5}$ emissions (gr of $PM_{2.5}$ per tkm)
  - PM_{10} emissions (gr of PM_{10} per tkm)
  - NO_X emissions (kg of NO_X per tkm)
  - CH_4 emissions (kg of CH_4 per tkm)
  - NMVOC emissions (gr of NMVOC per tkm)
- Presence of environmental quality labels (type of label(s) in possession)
- Environmental responsibility taken (number of ‘green policies’ in effect)
- EURO-x trucks in use (number / % of EURO-3, 4, 5 trucks in use)
- Fossil fuel needed (lt/km, lt/tonne, km/lt, MJ/km [rail], MJ/tonne [rail])
- Renewable energy needed (lt/km, lt/tonne, km/lt, MJ/km [rail], MJ/tonne [rail])
- Energy source (% of renewable over total energy used).

There are some remarks that need to be made on the above KPI list:

1. The categorization of KPIs provided in the text (page 47 of D2.1) is different to that of Annex 5 of the same document. The list as presented above is the best guess taking into consideration both citations.

2. The hierarchy of KPIs (trees) is not clear in cases like flexibility, documentation accuracy and gasses and air polluters, where lower level indicators of different units are combined into a single KPI.
3. The units of some indicators like CO_2 and SO_2 emissions are questionable.
4. The indicators 'fossil fuel needed' and 'renewable energy needed' are basically identical. They should be replaced by a single indicator 'energy consumption', measured in MJ/tkm.

4.1.5 Terminal benchmarking

This is yet another task, the final report of which is not currently available, confining our review to the relevant material of Deliverable D2.1.

The methodology applied is similar to the one for transport chain benchmarking. The suggested KPIs are listed below:

General/factual information

- Terminal ownership (public/private/mixed)
- Terminal access (open to public/restrictions applied)
- Location (place and distance from major city)
- Type of intermodal terminal (inland/seaport and bimodal/trimodal)
- Surface area (sq.m.)
- Rail connection (yes/no)
- Rail yard (track length in meters)
- Rail yard (number of tracks and length per track)
- Water connection (yes/no, if yes: water depth of access channel & allowable ship size (DWT, length, width)
- IWT quay wall (yes/no, if yes: quay length and water depth)
- Stacking cranes (number of cranes)
- Total staff (FTE)
  of which: - in office
  - on the yard
- Operating days (number of days per year)
- Opening hours (hours per day)

Services

- Regulated goods (yes/no, if yes: % of regulated goods over total throughput)
- Vendor managed inventories (yes/no, if yes: number of contracts for VMI services)
- Storage depot (yes/no, if yes: storage cost per TEU per day [full/empty])
- Documentation (EDI capacity/barcode/scanning/RFID possibilities)
- Planning based on time slots for operators (yes/no)
- Reefer services (yes/no, if yes: number of reefer slots)
- Container repair services (yes/no, if yes: repair facilities)
- Container cleaning services (yes/no, if yes: internal/external cleaning facilities)
- Catering services (yes/no, if yes: catering facilities)

Efficiency

- Average interchange time (between arrival and departure), truck (hours)
- Average interchange time (between arrival and departure), train (hours)
- Average interchange time (between arrival and departure), barge (hours)
- Average interchange time (between arrival and departure), sea vessel (hours)
- Throughput (TEUs/year)
  of which: - full
  - empty
  of which: - delivered by truck
  - delivered by train
  - delivered by barge
  - delivered by sea vessel
- Documentation performance monitoring (yes/no, if yes: hours per day spent on documentation issues)

Safety

- Number of safety incidents per year
- Number of injuries per year

Security

- AEO status (yes/no)

Quality

- ISO 9001 (yes/no, if yes: validity of certificate)
- ISO 14001 (yes/no, if yes: validity of certificate)
- ISO 14064 (yes/no, if yes: validity of certificate)
- ISO 18001 (yes/no, if yes: validity of certificate)
- ISO 28000 (yes/no, if yes: validity of certificate)
- Safety Quality Assessment Scheme (yes/no, if yes: validity of certificate)
- Other quality related programmes (yes/no, if yes: specify)
- Terminal damages (cost of damage repairs per month)
- Number of complaints per month

Energy consumption

- Electricity consumed (kWh per year)
  of which from ‘green’ sources (% of total electricity consumed)
- Other fuels consumed (liters of diesel/petrol consumed per year)

Furthermore, a number of derivative indicators like ‘throughput per crane’ or ‘CO_2 emissions per TEU’ are proposed based on those listed above.

Responding to suggestions received from the project's High Level Support Group, the process of terminal benchmarking as described above was later redesigned to include the following two activities:

The first activity involved the estimation of the average values of a small number of performance indicators for European intermodal freight terminals (IFTs) to be used as default values in the terminal database of the second activity. The case study approach (amongst 11 intermodal terminals) was followed for this purpose. On the basis of some general indications, the following findings can be listed:

- intermodal freight terminals are rather flexible towards opening hours
- almost all terminals operate under an ISO 9001 quality management system
- almost 50 % of the terminals operate under an ISO 14001 environmental management system
- seaports tend to adopt ISO 28000 – security management - and/or the ISPS code[5] program
- sustainability in terms of 'green' energy has a low level of adoption[6]
- an average throughput cost (handling) of € 40 per TEU is reported
- the average interchange time gate in/out per truck is around 25 minutes
- the average interchange time barge to truck is around 4 minutes per container.

The second activity, which has received much more focus in the project and is almost finalised, comprises of:

1. Creation of a database with approximately 650 intermodal terminals (containers and swap bodies) in the EU27. This database contains the following information for each terminal:
   - Location (country, city, address, postal code)
   - Contact details (terminal name, terminal operator, website, telephone, e-mail)
   - Connected modes (road, rail, inland waterway transport, sea)
2. An algorithm that links the most important terminals in Europe. This algorithm enables the user of the terminal database to obtain insight in the European network of services between intermodal terminals. This system provides the following information for each terminal:
   - Available transport services to other terminals
   - The frequency of these services (number of departures per week to the destination terminal)
   - The transport time of these services (time between day of departure and day of arrival in number of days)

   Once an origin terminal and destination city has been selected by the user, the database tool (MS-Access) provides an output report listing the existing connections (faster connection on top) between the terminals of origin and destination (direct connections and indirect connections with a maximum of one transhipment terminal). This information will be used as an input for the e-Tool.

[5] International Ship and Port facility Security code

[6] Austrian terminals do report 'green' energy %

4.1.6 Good practices and lessons learned

A selection of the most interesting "good practice" cases among those examined by BE Logic is presented in Section 5.4 of this report. What is summarised below is the KPIs that have been affected the most in these cases:

Environment driven

- reduction of CO_2 emissions
- reduction of carbon monoxide emissions
- reduction of hydrocarbons emissions
- reduction of particulate emissions
- reduction of fuel consumption

Cost driven

- better use of loading capacity (load factor)
- optimization of loading units (load factor)
- reduction of loading errors
- reduction of distribution errors and improvements in route scheduling
- reduction of truck trips

Time driven

- reduction of transport time
- reduction of time for additional logistic services in terminals

Reliability

- fixed time schedules.

4.1.7 Existing standards in transport logistics

The project identified 14 valid standards, all adopted by the CEN/CT 320 working group ("Transport – Logistics and Services"). Six among them are related to intermodal transport and are listed below:

- EN 14310:2002 Declaration and reporting of environmental performance in freight transport chains
- EN 12507:2005 Guidance notes on the application of EN ISO 9001:2000 to the road transportation, storage, distribution and railway goods industries
- EN 12798:2006 Quality management system requirements to supplement EN ISO 9001 for the transport of dangerous goods with regard to safety
- EN 13011:2000 Declaration of quality performance in transport chains
- EN 13876:2002 Code of practice for the provision of cargo transport services
- EN 15696:2007 Specification for self-storage services.

The content of these standards is presented and each document is classified in one of eight quality domains defined by the project.

Furthermore, 32 quality-related initiatives contained in policy papers, industry reports, inter-organizational agreements, European studies/projects etc. are identified and analyzed in the same way.

What is of interest for KPI selection is the number of documents (among a total of 32) that use certain criteria as instruments for improvement in quality performance:

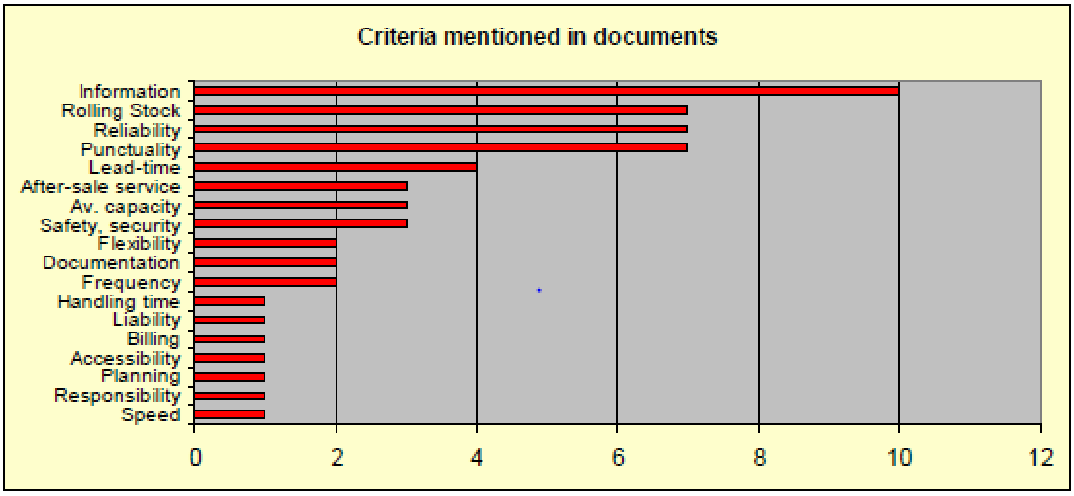

Figure 1. Criteria for improving quality performance (Source: VGTU, 2009)

Quite interesting from the SuperGreen perspective are also the references to and brief presentations of five documents falling under the "Quality management along transport corridors" domain. These documents are:

- BRAVO – Brenner Rail Freight Action Strategy, FP6, 2004-2007
- Developing a Quality Strategy for Combined Transport, Booz, Allen & Hamilton, on behalf of UIRR, supported by DG TREN through the PACT facility, 2000
- Rail Freight Quality: The Challenge, CER report, 2003
- Interoperability of the Trans-European Rail System, MoU by UIC, UNIFE, CER, EIM, 2005
- East West Transport Corridor Strategy and Action Plan, Interreg IIIB, 2005-2007.

The basic conclusion of a series of interviews with stakeholders on the issue of standardization is that, due to the broad diversity in logistic services and consumer needs, the most effective improvement measures are quality standards implemented and utilized by the actors themselves, in an approach similar to those of ISO 9001 and ISO 14001. Along the same line, a comprehensive system of KPIs can ensure a certain level of service quality only if such a system is agreed by the parties involved at the time of contracting, and is subsequently monitored by the contracting parties themselves.

At a later stage, the project plans to develop and evaluate (by the Delphi method) a model standard for transport logistic services.

4.1.8 The e-benchmarking tool

There are significant differences between the BE Logic e-benchmarking tool (the ‘tool’), as it is provided at the project’s web site, and Deliverable 2.5, which apparently describes a different version of it. Therefore, our review will be based only on our experimentation with the tool itself.

As is, the tool covers only the transport chain part of the project, and more specifically, benchmarking of alternative routes and modal combinations for moving a certain cargo between two points.

The input part of the model consists of 9 steps as shown below:

Step 0 – Transport Description

- Origin — Selection from drop-down list
- Destination — Selection from drop-down list
- Approximate distance (km)
- Type of transport chain — Selection from drop-down list:
  - Door to door
  - Door to terminal
  - Terminal to door
  - Terminal to terminal
  - Combined transport
- Topography — Selection from drop-down list:
  - Easy (flat, 0 - 400 meters)
  - Medium (hills, 400 - 800 meters)
  - Difficult (mountains, > 800 meters)
- Congestion — Selection from drop-down list:
  - Low (< 0.5 h)
  - Medium (0.5 – 1.0 h)
  - High (> 1.0 h)
- Commodity — Container (only choice)
- Total trip length — Label based on distance specified

Step 1 – New Alternative

- Origin — Selection from drop-down list
- Destination — Selection from drop-down list
- Distance (km)
- Mode — Selection from drop-down list:
  - Rail
  - Road
  - Sea
  - Inland

(The above 4 attributes are required for each link of the transport chain alternative under examination.)

Step 2 – Transport Time Indicator

The indicator is calculated as the sum of:

- Handling time (h)
- Driving/sailing time (h)
- Waiting time (h)

(The breakdown is not necessary. The total time figure, if available, can be introduced in the 'driving/sailing time' attribute.)

Step 3 – Transport cost indicator

The indicator is calculated as the sum of:

- Vehicle/vessel cost (€)
- Fuel/energy cost (€)
- Infrastructure charges (€)
- Cleaning cost (€)
- Terminal/handling cost (€)
- Handling fee, loading (€)
- Handling fee, unloading (€)
- Terminal charges (€)
- Container rent (€)
- Inspection cost (€)
- Insurance (€)
- Overhead cost (€)
- Inventory cost (€)
- Other costs (€)

(The breakdown is not necessary. The total cost figure, if available, can be introduced in the 'vehicle/vessel cost' attribute.)

Step 4 – Flexibility indicator

The indicator is calculated as the mean of:

- Demand adaptability (scale 1 to 5)
- Size adaptability (scale 1 to 5)
- Timetable adaptability (scale 1 to 5
- Robustness (scale 1 to 5)

Step 5 – Reliability of service indicator

The indicator is calculated as the mean of:

- Punctuality (scale 1 to 5)
- Transit time variation (scale 1 to 5)
- Reputation (scale 1 to 5
- Complaints (scale 1 to 5)

Step 6 – Quality indicator

The indicator is calculated as the mean of:

- Tracking and tracing (scale 1 to 5)
- Payment terms (scale 1 to 5)
- Quality system presence (scale 1 to 5
- Invoicing accuracy (scale 1 to 5)
- Proof of delivery – POD (scale 1 to 5)
- Certificate of delivery – COD (scale 1 to 5)

Step 7 – Environmental sustainability indicator

The indicator is based on the variables shown below. There is a direct link to the EcoTransIT model, which can be used for obtaining the necessary values.

- CO_2 emissions (in tonnes)
- SO_2 emissions (in kg)
- PM_{10} emissions (in kg)
- NO_X emissions (in kg)
- Non-methane hydrocarbons (in kg)

Step 8 – Indicator weights

The step consists of two screens. The first one concerns the relative weights of the six KPIs (time, cost, flexibility, reliability, quality, sustainability). The user is requested to rank these KPIs from 1 to 6 according to the importance attached to each one. Then, he/she can either use the pre-determined weights (26% for rank 1, 24% for 2, 20% for 3, 14% for 4, 10% for 5, and 6% for 6) or can specify his/her own weights provided that they sum up to 100%.

With the second screen, the user specifies weights to be used for combining the 5 attributes of the environmental sustainability indicator. Again, they should sum up to 100%.

Steps 1 to 8 are repeated for each alternative chain the user wishes to compare to the basic one.

The result screen of the tool provides the scores of each alternative by indicator, and a ranking of the alternatives examined based on their final scores.

The following remarks can be made on the tool, especially in relation to its applicability in the framework of SuperGreen:

1. The origin, destination and intermediate nodes of a transport chain alternative can only be selected from a drop-down menu, imposing unnecessary restrictions
2. The attributes 'type of transport chain', 'topography', 'congestion' and 'total trip length' of Step 0 are labels allowing comparisons among similar chains. However, the tool doesn't offer this functionality.
3. There is no reference to the type and weight of cargo, meaning that there is no way to estimate values on a 'per tonne' or 'per tkm' basis, which are necessary for comparisons

between different origin-destination pairs within the same corridor or between different corridors.
4. The use of relative weights for combining the six KPIs is a very simple and effective way to take into consideration different ‘points of view’ as exhibited by different stakeholders.
5. The same weighing approach could be used for the flexibility, reliability and quality indicators.
6. The exact formulae used for calculating the sustainability KPI and the final alternative scores are not provided in the project literature.

The general conclusion is that the tool, as is, cannot be used for SuperGreen, as it is not designed for corridor benchmarking. However, the relative weighing scheme is very useful in combining KPIs and should be considered by SuperGreen. Given that SuperGreen is not targeted to SMEs, the importance of the graphical user interface characteristics of the tool is reduced and, the relevant calculations can be done faster through a simple spreadsheet.

4.1.9 Logistics market analysis and aggregate performance indicators

The aim of this BE Logic task is to assess, for year 2020, the evolution of the Socio-cultural, Technological, Economic, Ecological, and Political (STEEP) environment, the supply chain management trends, and the freight transportation system characteristics and performance through a set of aggregate indicators.

First, the major drivers of the external environment believed to have an impact on the development of trends and the performance of the freight transport system are identified. They are presented in Table 1, together with the projected change, in terms of direction and intensity, for year 2020. It should be mentioned that all projections of this section are basically qualitative, supported by quantitative results where available.

The next step involves the identification of major supply chain trends. Their evolution, as affected by the external drivers is examined, and the resulting projections are shown in Table 2.

Similarly, the major freight transport trends are identified. Their evolution is examined in relation to the external drivers and the supply chain trends as presented in the previous tables (Table 3). Freight transport trends are analysed modal wise.

At this point, the Aggregate Performance Indicators (APIs), reflecting the performance of the freight transport system at a strategic level, are entered in the analysis. APIs are higher-level characteristics than the KPIs developed in other tasks of the BE Logic project. The APIs (refer to Table 4) are expressed at a modal level, as opposed to KPIs, which are expressed at company/terminal/transport chain level.

It is expected that the results of this analysis will provide guidance to the users of the e-benchmarking tool regarding the trends prevailing in the environment, organization, operation, and management of the freight transport system. Therefore, they have to be considered in parallel to the KPIs resulting from the tool.

Their aggregate nature fits well with the objectives of SuperGreen. Aggregation, however, concerns modes and not corridors.

Table 1. Major drivers affecting the freight transport system

Category	Driver	Direction / intensity of change for 2020
Socio-cultural	EU population projections	+
	Working population	-
	Concentration of population in financially dominant regions	++
	Increase in individualisation	++
	Proliferation of electronic business	+++
	Increase of social and environmental consciousness	+++
Technological	Road vehicle engines with stricter environmental standards	++
	Development of more efficient cargo handling and transport technologies	++
	Proliferation of ICT technologies for vehicle/cargo management	+++
	Advancements in intelligent transportation systems and technologies	+++
	Advancements in ICT for supply chain security	+++
Economic	Long-term projected increase in EU economic activity	0 / +
	Increase of EU trade integration with international partners	++
	Globalisation of industry and services	0
	Market enlargement	++
Ecological	Reduction in oil reserves	++
	Increase in total emissions produced by transportation	++
Political	Deregulation of transport activity	+
	Harmonisation of transport infrastructure	++
	Connection of European transport policy with energy and environmental policy	++
	Internalisation of external costs	++
Legend: + / -: moderate increase / decrease, ++ / --: significant increase / decrease, +++ / ---: very significant increase / decrease (and combinations thereof)		

Table 2. Supply chain trends

Category	Trend	Direction / intensity of change for 2020
Spatial structure	Spatial concentration of production	+++
	Spatial concentration of inventory	+++
	Wider sourcing of supplies and wider distribution of goods	+++
Organisation & management	Supply chain integration	+++
	Agility / adaptability	+++
Supply chain flows	Reverse logistics	+++
	Information sharing	+++
	Increase in direct deliveries	+++
Legend: + / -: moderate increase / decrease, ++ / --: significant increase / decrease, +++ / ---: very significant increase / decrease (and combinations thereof)		

Table 3. Freight transport trends

Category	Trend	Direction / intensity of change for 2020
Freight transport demand	Quantities of freight transported in tonnes	++ (for road, rail, SSS) +/++ (for IWT)
	Distances travelled in km	+++ (for road) ++/+++ (for rail) + (for IWT, SSS)
	Freight transport activity in tkm	+++ (for road, rail) +/++ (for IWT) ++ (for SSS) In terms of modal split: road share will be slightly reduced rail share will be reduced but at slower rate SSS share will increase IWT share will remain unchanged
Freight transport supply	Fleet size	0/+ (for road) -/-- (for rail, IWT) N/A (for SSS)
	Fleet composition (in terms of clean technologies)	++/+++ (for road) +/++ (for rail, IWT) ++ (for SSS)
	Vehicle size	+/++ (for road, rail, IWT) N/A (for SSS)
	Transportation infrastructure capacity	+/++ (for road) ++ (for rail) + (for IWT, SSS)
	Terminal infrastructure capacity	Same as above
Demand-supply interaction	Vehicle capacity utilisation (load factor)	+++ (for road) +/++ (for other modes)
	En-route congestion	+ (for road, rail) 0/+ (for IWT, SSS)
Legend: + / -: moderate increase / decrease, ++ / --: significant increase / decrease,		

+++ / ---: very significant increase / decrease (and combinations thereof)

Table 4. Aggregate Performance Indicators

Benchmarking area	APIs	Definition	Direction / intensity of change for 2020
Transport chain	Frequency of service	Ability of mode to offer frequent services that are in line with the respective demand	++ (for road) + (for rail, IWT, SSS)
	Flexibility of service	Ability of mode to adjust the provision of its services in order to meet changes (sudden or anticipated) in demand	++ (for road) + (for rail, IWT, SSS)
	Reliability of service	Ability of mode to offer services that are punctual and according to the published schedule or promised delivery date and time	+/++ (for road) + (for rail, IWT, SSS)
	Environmental intensity	Emissions produced per unit of transport activity (e.g. kg of CO2/tkm)	-/-- (for road) - (for rail, IWT, SSS)
	Energy intensity	Energy consumed per unit of transport activity (e.g. toe/tkm)	-/-- (for road) - (for rail, IWT, SSS)
	Operating cost	Operating cost per unit of transport activity (e.g. €/tkm)	0 (for all modes)
Terminal	Terminal utilization and congestion	The level of use of the available terminal capacity	++/+++ (for road/rail terminals) ++ (for sea ports) 0 (for inland waterway term.)
	Environmental pollution	Emissions produced per unit of cargo handled	-- (for all terminals)
	Energy use	Energy consumed per unit of cargo handled	- (for all terminals)
Policy	Infrastructure charges	Level of charges for infrastructure use	++

	Taxation levels	Level of taxes levied on transport system users	+ (for old technology vehicles and fossil fuels) - (for clean technology vehicles and alternative fuels)
	Transport funding	Nature and level of funding for the development of transport infrastructure	+ (for private funds) - (for state funding)
Legend: + / -: moderate increase / decrease, ++ / --: significant increase / decrease, +++ / ---: very significant increase / decrease (and combinations thereof)			

4.2 The InteGRail project

4.2.1 Introduction

This text is based on the project final report[7] and Dings et al (2008)[8].

InteGRail (Intelligent Integration of Railway Systems) was established in 2005 to address the growing demand for an efficient and integrated railway system in Europe. The project was funded under EU FP6 and developed a method to assess the performance of railways and to study the influence of changes in lower level performance indicators to the overall transport volume. There were 40 project participants, including railway and infrastructure companies, academic institutions, consultancies and technology providers. 11 million Euro out of a total project budget of 20 million was contributed by the European Union.

The main result of the InteGRail project is an information sharing platform that allows stakeholders to share information on the performance of their processes, making them able to optimise their contribution to the overall railway performance goals rather than optimising only their own performance. The project has developed an IT platform that allows the main actors (operators, traffic managers, infrastructure managers and rolling stock managers) to share information. A KPI Assessment tool is used in the project to evaluate the effect of information sharing examples.

4.2.2 Project description

While separation of company responsibilities between state controlled infrastructure management, railway operators and a number of subcontractors has helped creating an open market, separation of processes has reduced the awareness of the overall performance, and thus

[7] InteGRail – Publishable Final Avtivity Report, 13/04/2010.

[8] Pieter Dings, Ronald Bezemer, Danuše Marusičová, Christian Weber (2008), Improving the performance of the railways, paper presented at the 2008 WCRR Conference.

has the risk of impeding rail transport growth. InteGRail has identified that there is a strong relation between the different railway players as well as a need for various integration initiatives to enable process optimisation to take the interdependency between the various subsystems of one big railway system into account. The project is focussed on technical interdependency and will deal with cost matters at a later stage.

According to InteGRail, optimising the whole railway system requires improvements on two different levels:

- improvement of the subsystem performance, and
- improved cooperation of the different systems.

The objective of InteGRail is to enable information and its context to be shared within the railway system and to optimise decision making as a means to improve performance.

This is achieved through

1. enabling sharing of information to increase efficiency and quality and to support the business objectives of railway undertakings and infrastructure managers,
2. ensuring that the right information is available at the right time in the right place,
3. identifying ways of using the information more effectively for maintenance optimisation,
4. identifying ways of combining and using information effectively for management requirements,
5. ensuring that the information can be transmitted effectively to decision makers, and
6. demonstrating how improved information creation and sharing will enable performance improvement.

InteGRail does not replace existing systems but will be used in conjunction with them. InteGRail delivers a specification of a standard platform and protocol to interface existing or new information systems to enable exchanging key information between subsystems.

4.2.3 Methodology

InteGRail methodology follows an approach combining top-down and bottom-up activities, as seen below:

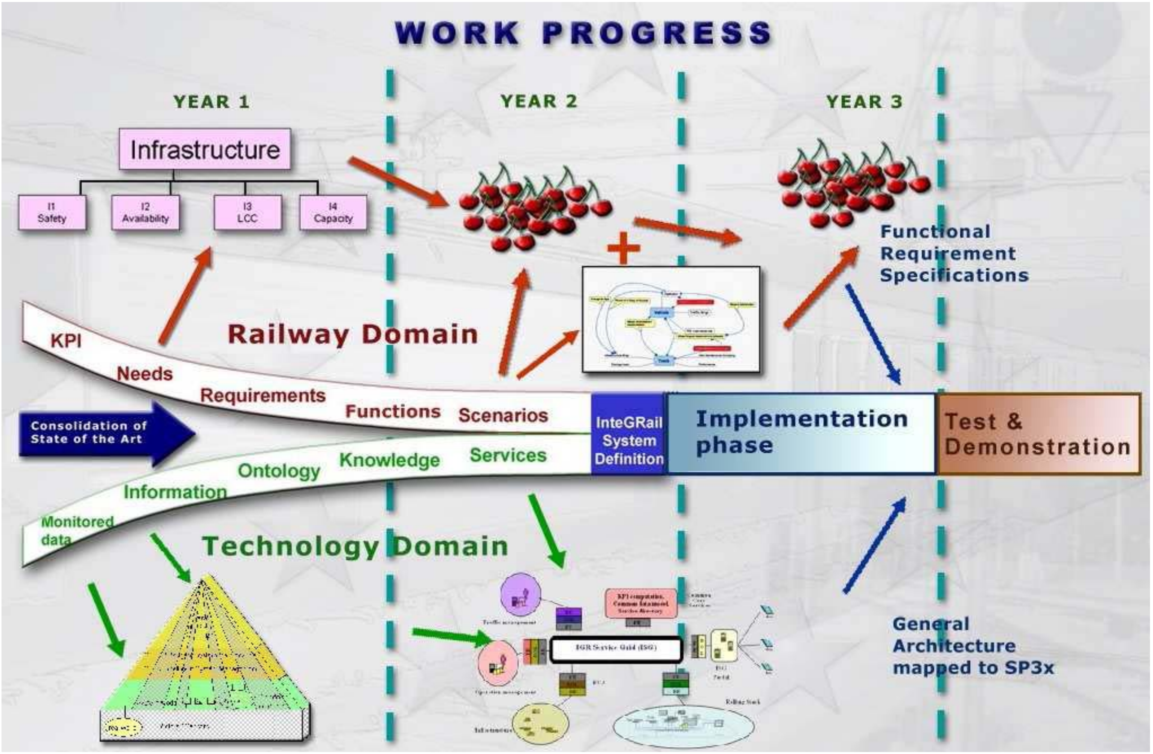

Figure 2. The InteGRail approach (Source: InteGRail Final Report)

The top-down approach defines a high-level description of the railway system in terms of Key Performance Indicators (KPI) for performance measurement and assessment. A KPI-tree for each of the four subsystems (rolling-stock, infrastructure, operation, traffic management) is produced to relate each KPI to the parameters which have influence on it. Links between KPIs in the different trees are identified and mapped. The higher levels of the KPI trees, which can be seen in the Figure 3 below, depend on other performance indicators and parameters at lower levels, but formulas and quantitative weights associated to each link in the three were not defined in the project.

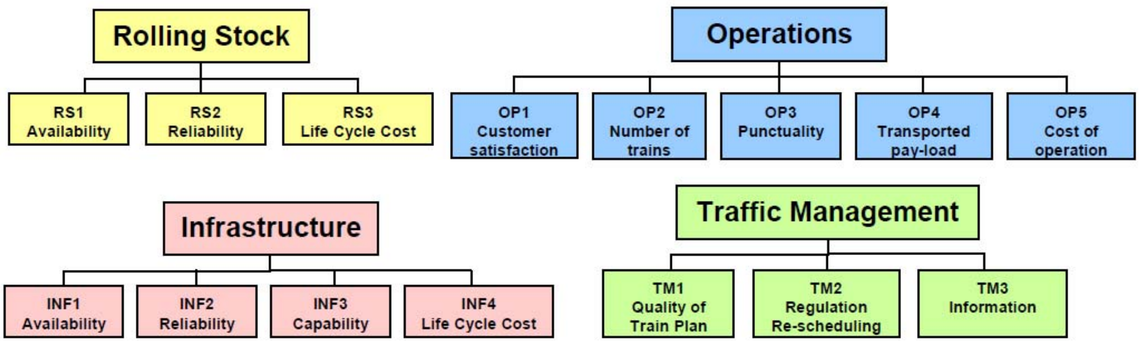

Figure 3. The InteGRail KPI-trees (Source: InteGRail Final Report)

Further analysis allowed derivation of user needs/requirements. Requirements were prioritised according to the evaluation carried out by railway stakeholders and where further analysed to identify the needed functions (cherries) which should be implemented. The resulting list of functions was made up of around 200 functions and further filtering and selection was needed.

The bottom-up approach analyses the current practices and requirements starting from suitable questionnaires. The InteGRail teams identified the items which in the future should be monitored by diagnostic facilities for rolling stock and infrastructure, including infrastructure-rolling stock cooperation and interaction. Available technologies were analysed, in order to convert data into information and allow further intelligent processing.

A step-by-step convergence led to the definition of a system architecture, while final results are reflected in the InteGRail Reference Technology Platform.

4.2.4 Output

InteGRail produced two types of results:

- a Reference Technology Platform, i.e. an open railway specification, to become a standard, and
- a number of Application Prototypes in different railway areas, where there is a potential for improvement.

The Reference Technology Platform is the core InteGRail solution and the basis for InteGRail applications. It is a middleware providing a common interface between applications and the existing network infrastructure.

The platform includes two main layers:

- the application-to-application layer, which defines how to properly represent, retrieve, process and finally understand information, and
- the high-level communication layers, which are responsible for transferring information, moving it from an application to another.

The Reference Technology Platform is able to decouple applications from the details of the supporting networks to produce two main benefits:

- reduce developing costs related to connecting together new or existing systems, and
- enable compatibility between all information systems.

In addition, an InteGRail Information System (IGRIS) has been developed, where the applications can cooperate with each other, as part of a single railway system.

Other important outputs of the project are:

- *A standard Railway KPI Structure:* As discussed above, InteGRail has defined a number of KPI trees, addressing the main areas of the railways. The formulas and quantitative weights associated to each link in the tree have not been defined, as they require a consensus agreement between all railway operators. Starting from InteGRail results, complete standard KPI trees can be defined, leading to standardization proposals.

- *An Ontology based standard Railway Data Model:* A railway system is complex and produces continuously huge quantities of data, most in proprietary formats, which are difficult to understand, elaborate and share. To be able to improve the ability to extract data efficiently, InteGRail produced a first kernel of a Railway Domain Ontology (RDO). It aims at producing a standard ontology in the railway domain, but there is still a need to refine and validate the current version of the RDO.

- *A standard Railway Service Grid Architecture:* InteGRail has defined an integrated information system architecture, i.e. a platform for implementation of large scale integrated systems.

- *A standard Railway Intelligent Communication Framework (ICOM):* The framework facilitates decoupling of applications from the details of the specific protocols and bearers, offering a common interface and a set of standard, parameterised services.

- *A KPI Assessment Tool:* The tool is a PC based software tool that can be used to study the performance of railways. Using a tree that represents the interactions between the individual railway processes (expressed through KPIs), the tool allows to model, calculate and visualise the performance of railway situations. In addition, the tool can help testing the KPI model and check its consistency.

- *Demonstrators:* Tools have been combined using the Reference Technology Platform, to show their effectiveness in business environments, grouped together in specific Demonstration Scenarios.

Some of the main InteGRail results, specifically those related to the Technology Reference Platform, can lead to standardisation proposals:

1. A standard Railway KPI structure
2. Ontology based standard Railway Data Model
3. Standard Railway Service Grid Architecture
4. Standard Railway Intelligent Communication Framework: ICOM.

4.2.5 Relevance for SuperGreen

There are still many important issues to address in order to improve the performance and competitiveness of railway systems. There is a need to work out standardisation agreements, rules and business procedures for information exchange and establishing of new organisational models. In such context, new products based on InteGRail and existing products adapted using InteGRail guidelines can start building improved railway systems.

However, the project has limited direct relevance for SuperGreen, with the exception of the KPI-tree structure. The tool will not be used to generate corridor data, but lessons learned on barriers and improvement potentials may have value for the project.

4.3 The Shipping KPI project[9]

4.3.1 Phase 1

A group of 18 leading ship management and ship owning companies (The Sponsor Group) agreed late 2004 to cooperate in order to drive the process for establishing an international standard for Key Performance Indicators (KPI) in shipping. The members of the Sponsor Group emphasized their unique competence and experience ensuring the KPI Standard would be practical to use, would give a representative and transparent picture of the performance, and would be economical and practical to implement. A pilot project was initiated in January 2005 to test methodologies to measure the value of different KPIs as regards to "quality of operation" in shipping. The pilot project was followed the "Shipping KPI Phase 1" sponsored by to the research Council of Norway. The project was launched in January 2006 and ended in 2008.

The main objective of the Phase 1 project was to establish an international standard measuring performance in shipping (KPIs) which lead to:

- increased transparency on quality, safety and environmental performance in ship operation,
- enhanced governance in ship operation, and
- future regulatory developments in shipping towards “process output” regulation.

The Shipping KPI concept is based on aggregating and collating information for two purposes: internal improvement and external communication. The Shipping KPI Standard is built up hierarchically with 7 Shipping Performance Indexes (SPIs), 34 Key Performance Indicators (KPIs) and 66 Performance Indicators (PIs).

The **Performance Indicator (PI)** is directly observable or measurable within the company (as an example: number of incidents, fuel consumption, exposure hours etc.). In the Shipping KPI model more than 60 PIs are defined today. The PIs are based on data capture (measurements or counters) directly from a vessel or from the ship’s management. Data is collected once and re-used within the Shipping KPI Standard in order to reduce the amount of data.

The **Key Performance Indicator (KPI)** is built combining a set of PIs. Most of the KPIs are grouped with respect to the balanced scorecard perspectives in addition to a HSE perspective. 33 KPIs are identified in the model. On KPI level a form of normalization takes place. The KPI are scaled into a range from 0-100, where zero indicates unacceptable and 100 is outstanding performance. This makes it possible to compare vessels with different characteristics or amount of data captured.

Each **Shipping Performance Index (SPI)** combines a set of relevant KPIs that express the organizational ability to perform within the theme of interest. There is a mathematical relation between SPIs (high level indexes) which are calculated from Key Performance Indicators, and KPIs which are calculated from Performance Indicators (lowest level). The model defines 7 SPIs:

- Environmental Performance,

[9] http://www.sintef.com/Projectweb/Shipping-KPI/

- Human Relations Performance,
- Navigation Performance,
- Operational Performance.
- Safety Performance,
- Security Performance,
- Technical Performance.

The structure of the project's indicator trees is depicted in Figure 4 below. As an example, the structure of Safety performance and Security performance SPIs is presented in Appendices I and II respectively.

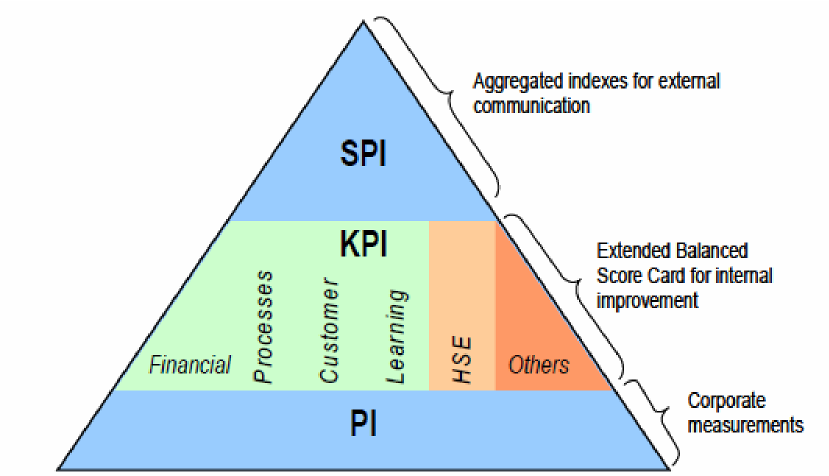

Figure 4. The structure of Shipping KPI indicator trees (Source: MARINTEK)

4.3.2 Phase 2

Phase 2 of the project started up in March 2009. During the following two years the Shipping KPI standard will be validated and elaborated through external stakeholders involvement. The project will contribute to increased transparency in ship management and operations enabling identification of low performing vessels and companies, permitting benchmarking between similar vessels and fleets, and by setting minimum operational performance requirements.

The goal is to:

- develop and facilitate the process for adoption of the principles of the Shipping Performance Indexes by the external stakeholders,
- validate the KPI model and its sensitivity and ability to express performance through data capture from major shipping companies and by theoretical studies, and
- develop a prototype process and tool for benchmarking the industry.

Shipping KPI Phase 2 with its focus on Shipping Indexes for external communication aims to contribute to improved environmental, safety and efficiency performance; in other words improve the competiveness of the shipping companies.

4.3.3 Value to the SuperGreen project

Shipping KPI proposes a shipping industry standard for defining, measuring and reporting information on operational performance. The project has developed a model that uses three different categories of measurements: Shipping Perfomance Indexes (SPIs), Key Performance Indicators (KPIs) and Performance Indicators (PIs). The project has identified more than 60 performance indicators (e.g. number of incidents, fuel consumption, emitted mass of CO2, number of officers onboard) and uses a model for aggregating the PIs into 34 KPIs and 7 SPIs at the highest level of aggregation. The work in the first phase has been focusing at a theoretical approach. Many of the PIs identified in the model are not tied directly to an easily accessible public database, so the usability for the SuperGreen project is limited at this stage. The ongoing Phase 2 of the project will develop a prototype tool to validate the model, but so far the project does not present a tool that will be available and usable for data collection in the SuperGreen project.

4.4 IMO's EEDI formula

The International Maritime Organization's (IMO) activities to combat air pollution from ships are very extensive. They concern, among other things, developing regulations to mitigate emissions, conducting studies to assess what are the most promising measures (technological operational, market-based or other), and engaging in discussions among stakeholders as to what actions should be taken. The relevant forum of the IMO is its Marine Environment Protection Committee (MEPC), a body that meets once or twice a year. A typical MEPC agenda on air pollution from ships numbers between 60 to 70 submissions, not counting those that are examined intersessionally, that this, between consecutive MEPC sessions.

It is not the scope of this section to go over relevant IMO regulatory activity, this being reserved for Task 2.3. Rather, here we shall focus on the so-called "Energy Efficiency Design Index" (EEDI), as this is a KPI that seems to be mostly relevant for shipping. Still, by way of background, the following can be briefly said.

Progress as regards air pollution from ships has been mixed and rather slow. On the positive side, in 2008 the Marine Environment Protection Committee (MEPC) of the IMO unanimously adopted amendments to the MARPOL Annex VI regulations. The main changes will see a progressive reduction in sulphur oxide (SOx) emissions from ships, with the global sulphur cap reduced initially to 3.50%, effective 1 January 2012; then progressively to 0.50%, effective 1 January 2020.

Furthermore, the report of Phase 1 of the update the 2000 IMO Green House Gas (GHG) Study was presented, which was conducted by an international consortium led by SuperGreen partner Marintek (Buhaug, et al 2008)10. According to this study, total CO_2 emissions from shipping

[10] Buhaug, Ø., J.J. Corbett, Ø. Endresen, V. Eyring, J. Faber, S. Hanayama, D.S. Lee, D. Lee, H. Lindstad, A. Mjelde, C. Pålsson, W. Wanquing, J.J. Winebrake, K. Yoshida (2008). Updated Study on Greenhouse Gas Emissions from Ships: Phase I Report, International Maritime Organization (IMO) London, UK, 1 September, 2008 (included as Annex in IMO document MEPC58/INF.6).

(both domestic and international) are estimated to range from 854 to 1,224 million tonnes (2007), with a 'consensus estimate' set at 1,019 million tonnes, or 3.3% of global CO_2 emissions. By comparison, electricity and heat production account for 35% of global CO_2 emissions, manufacturing industries and construction 18.2%, and transportation (all modes) 21.7%. Among transportation modes road accounts for 51% of all CO_2 emissions, shipping (including fishing) for 25%, aviation for 20% and rail for 4%.

Future projections of CO_2 emissions from shipping have a huge spread, from 700 million to 7,000 million tonnes by 2050, depending on what action is taken. Among ship types, according to the results of Phase 1, the three top fuel consuming categories of ships (and thus, those that produce most of the CO_2 emissions) are (i) container vessels of 3,000-5,000 TEUs, (ii) container vessels of 5,000-8,000 TEUs and (iii) RoPax Ferries with cruising speed of less than 25 knots. The common denominator of these three categories, which results in a high level of CO_2 emissions, is their high speed, at least as compared to other ship types.

To calculate CO_2 emissions, one has to multiply bunker consumption by an appropriate emissions factor, F_{CO2}. The factor of 3.17 has been the empirical mean value most commonly used in CO_2 emissions calculations based on fuel consumption. According to the IMO 2000 GHG study, the actual value of this coefficient may range from 3.159 (low value) to 3.175 (high value). The update of the IMO 2000 study (Buhaug et al, 2008), uses slightly lower coefficients, different for Heavy Fuel Oil and for Marine Diesel Oil. The actual values are 3.082 for Marine Diesel and Marine Gas Oils (MDO/MGO) and 3.021 for Heavy Fuel Oils (HFO)11.

Calculations aside, it is clear that the whole issue of GHG reduction is no less political as regards shipping as it is in general: at recent meetings of IMO's MEPC, there continued to be a clear split between industrialized member states, such as Japan, Denmark and other Northern European countries, and a group of developing countries including China, India and Brazil, on how to proceed. The latter countries typically speak in favour of the principle of "Common but differentiated responsibilities" (CBDR) under the UNFCCC. In their view, any mandatory regime aiming to reduce GHG emissions from ships engaged in international trade should be applicable exclusively to the countries listed in Annex I to the UNFCCC, therefore their strong wish is not to be included in any mandatory set of measures.

Mainly due to political reasons such as above, progress as regards regulating CO_2 and other GHGs continues to be very slow. In fact, the stated objective to finalize a mandatory Energy Efficiency Design Index (EEDI) of the environmental performance of new ships has been rather slow to complete. The same is true for the Energy Efficiency Operational Indicator (EEOI), which will be applicable to all ships. However, it looks like at least EEDI will be finalized in the forthcoming 61st session of MEPC (MEPC 61), to be held Sep. 27- Oct. 1, 2010.

Without going into technical details, one can state that the first index (EEDI) concerns the design of new ships and is foreseen to be mandatory and the second (EEOI) concerns the operation of all ships, new and existing, and is foreseen to be voluntary. The lower EEDI or EEOI is, the better a ship ranks environmentally, although several IMO delegations have expressed concerns that both indices have deficiencies.

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11 An online free emissions calculator for CO2 ,SO2 and NOx and various ship types and routes has ben developed by NTUA and is at http://www.martrans.org/emis/

MEPC 59 agreed to circulate the interim Guidelines on the method of calculation of the Energy Efficiency Design Index (EEDI) for new ships (IMO doc. MEPC.1/Circ.681) and the interim Guidelines for voluntary verification of EEDI (IMO doc. MEPC.1/Circ.682).

More precisely, the formula for EEDI, as described in IMO doc. MEPC.1/Circ.681 is the following:

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE} *\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_w}$$

There is no need to explain all these symbols here. The numerator in the formula is a function of all power generated by the ship (main engine and auxiliaries), and the denominator is a product of the ship's deadweight (or payload) and the ship's 'reference speed', appropriately defined as the speed corresponding to 75% of MCR, the Maximum Continuous Rating of the ship's main engine. The units of EEDI are grams of CO_2 per tonne mile.

The way this index will work is as follows: The EEDI of a new ship is to be compared with the so-called "EEDI (baseline)," which is defined as EEDI (baseline)= $aDWT^{-c}$, where DWT is the deadweight of the ship and a and c are positive coefficients determined by regression from the world fleet database, per major ship category. If a ship's EEDI is above the equivalent baseline, the ship would not be allowed to operate until and unless measures to fix the problem are taken.

After considerable debate, there is now a proposal before MEPC 61 that EEDI baselines be reduced by 10% by 2013, by 25% by 2018 and by 35% by 2023[12]. All ships above 400 GRT will be included, although ro-ro ships will be excluded from the first phase of implementation, as some issues on these ships are still unresolved. There is also considerable detail on how the whole process will be implemented, as an amendment to Annex VI of MARPOL, and discussion on these issues, some of which are still open, is expected at MEPC 61.

As the impending finalization of the EEDI index will be a major milestone by the IMO on GHGs, it is still unclear how well this index will work in practice, and as a matter of fact there have been numerous concerns on its future use. Note that this KPI is an indirect one, as the data it assumes for its calculation may not necessarily represent those that will be encountered in a ship's life cycle. Note also that there is no equivalent index for a fleet of ships, or for a maritime corridor. In addition, there are issues that merit discussion on the usefulness of the formula.

For instance, an important caveat concerns the speed data that is used in the regressions. The typical assumption by all who perform regressions is that that the service speed that is recorded in fleet databases is equal or close to the one corresponding to the 75% MCR level. Yet, this may not usually be the case, as in some databases service speed is sometimes recorded at the 100% MCR level. Even if service speeds are accurately reported by ship owners to database developers (which is not usually the case), a deviation in the value of speed used in the formula would result in a deviation in the value of EEDI, which can be significant. And even if such an error is not systematic, the entire EEDI baseline regression results would be less reliable because of such inconsistencies. Thus, to the extent that ship speeds are drawn from such databases, caution is

[12] See IMO doc. MEPC 61/5/3, Report of the outcome of the Intersessional Meeting of the Working Group on Energy Efficiency Measures for Ships, 7 July 2010.

necessary on how they are obtained, how they are used and how the results of the regressions are interpreted.

Another concern is that the combination of formulae for EEDI and EEDI (baseline) essentially imposes a speed limit, and, in turn, an upper bound on the ship's MCR, shifting the focus from developing the most efficient hull forms, engines or propellers to reduce CO_2, to achieving the same objective just by reducing power and service speed. The speed limit is due to the non-linear relationship between speed and power. In fact, some circles believe that imposing an upper bound on the reference speed V (and hence on MCR) would favor the construction of underpowered ships, which, in their attempt to go faster or just maintain speed in bad weather, might emit disproportionately more CO_2. Smaller engines going at a higher percentage of MCR might emit more CO_2 than those produced by larger engines going at a lower percentage, even though the EEDI might be lower.

Note that there is nothing in the EEDI or EEDI (baseline) formulae that would prevent a ship to sail at speeds higher than V, the speed corresponding to 75% MCR. Other possible side-effects of reduced speeds include (a) adding more ships to match demand throughput, (b) increasing cargo inventory costs due to delayed delivery, (c) increasing freight rates due to a reduction in ton-mile capacity, (d) reduced manoeuvrability and navigational safety, and (e) inducing reverse modal shifts to land-based modes (mainly road), something that would increase overall GHG emissions.

Some attempts to propose different EEDI baseline formulae that incorporate speed into the equation so that the speed limit effect would be alleviated were not accepted, on the ground that the ship owner should retain the option to reduce power as a means to reduce CO_2. However, caution was expressed that the safety of a ship should not be compromised in the process.

Based on the above, it is our opinion that the usefulness of the EEDI index as a KPI in the context of a maritime or intermodal corridor is limited, both because the index is defined on an individual vehicle basis and because of the concerns raised above.

4.5 The NTM model

The Network for Transport and Environment (NTM) is a non-profit organisation that specializes in the field of standardization of environmental performance assessment by establishing methods and data that enable credible calculations of transports' environmental, climate and energy performance. NTM was initiated in 1993 by a variety of actors in the transport industry, above all transport providers and buyers of transport services. NTM has developed and offers web-based calculation tools for goods and passenger transportation. In addition, NTM is developing Product Category Rules (PCR) for transport services, from which Environmental Product Declarations (EPD) can be established for specific transport solutions. PCR/EPDs cover all modes of transport and take into consideration energy, green house gases and general regulated emissions. The PCR structure is based on the ISO 14 025 standard.

In 2008, NTM and IVL Swedish Environmental Research Institute started a strategic cooperation to develop the organisation further. The work to maintain and improve the transport models is carried out in working groups composed of NTM's members and by externally contracted experts.

There are presently four working groups:

- Goods & Logistics. The working group develops methods and environmental data for freight transportation. The first database for freight transportation's environmental performance was presented in 1997 and since then has been continuously developed to include more and more international methods and data. In 2002, a web-based calculation tool named NTMCalc Goods 1.0 became available, which the working group continuously develops further. The current work is focused on the improvements of methods, data and tools as well as on the education of users of the calculation model.
- Fuels: The goal of this working group is to agree on relevant energy and emission values for the operation of vehicles with traditional and alternative fuels. The material is published in reports which are presented on the homepage.
- Transport and procurement: The group aims at developing an effective method for the evaluation of transport providers' environmental performance. Currently, a tool for the evaluation of transport services is available.
- Travel: Not relevant for SuperGreen

The information on the NTM-calc tool provided below is based on:

- Magnus Swahn's article "How to evaluate transport's environmental performance" published in the June 2010 issue of the "GreenPort" magazine, and
- his presentation "Green Corridors – KPI" given at the SuperGreen stakeholders' workshop in Helsinki on June 28, 2010.

The tool, in its current state of development, calculates green house gases and regulated emissions of transport chains involving all transport modes. Calculations are based either on default values covering a wide range of vehicles/vessels and terminal operations, or user specified inputs in terms of energy consumption and emissions produced.

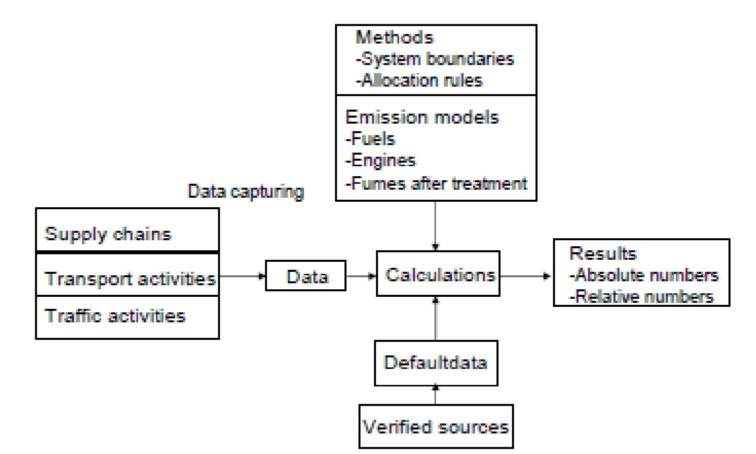

Figure 5. Overview of the NTM-calc environmental calculation (Source: Conlogic AB)

The tool is very systematic in its approach. The user is urged to describe the transport system under examination in a detailed and exhaustive manner so as to take into consideration factors like special needs imposed by the cargo type (refrigeration, etc.) and the relocation needs of vehicles/vessels and empty containers.

In addition the user is cautioned to select the proper boundaries of the system examined and be consistent in comparing input and output values. As shown in Figure 6 below, there have been four system boundaries defined:

- System boundary A includes traffic and transport related activities regarding engine operation for the propulsion and equipment for climate control of goods, as well as losses in fuel tanks and batteries. This includes the traffic-related terminal handling, i.e. when goods do not leave their vehicle/vessel.
- System boundary B includes in addition the supply of energy from energy source to the tank, battery and electric motor (trains). This is the minimum required system boundary for performance of comparisons between different modes of transport.
- System boundary C includes in addition to the above traffic infrastructure operation and maintenance.
- System boundary D includes in addition to the above vehicle, vessel, load units production and scrapping (life cycle approach).

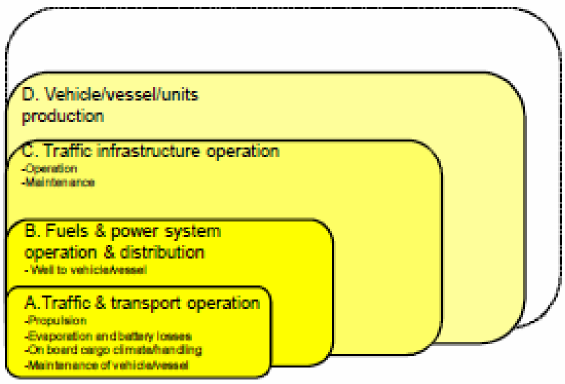

Figure 6. The NTM-calc definition of system boundaries (Source: Conlogic AB)

Tool results show the significance of load factor in relative emissions (Figure 7). This is expected since total fuel consumption and emissions do not increase proportinately to the amount of cargo carried.

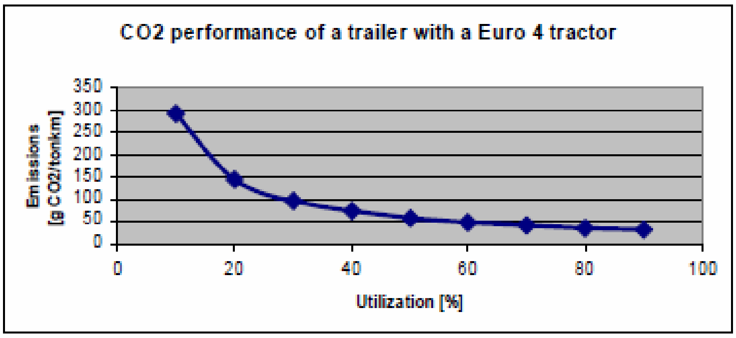

Figure 7. Relative emissions as a function of load factor (Source: Conlogic AB)

The tool is currently being further developed to handle performance assessment at **corridor level**. This will be an important development for SuperGreen, as it is the only tool found in our literature survey aiming at such comparisons. In addition to green house gases and other regulated emissions, the tool will be able to handle other KPIs like:

- costs
- traffic safety – fatalities per Mtkm
- traffic safety – serious injuries per Mtkm
- on time delivery – deviation from scheduled arrival time (hours/tkm)
- surface efficiency (vkm/m2)
- noise levels
- speed levels
- follow-up systems
- vulnerability / redundancy plans
- maintenance.

4.6 The EcoTransIT World model

4.6.1 Project identity

“EcoTransIT World” is an upgrade development of “EcotransIT”, a project which was initiated by five European railway companies in 2000: Railion AG, Schweizerische Bundesbahnen (SBB), Green Cargo AB, Trenitalia S.p.A, and Société Nationale des Chemins de Fer Français (SNCF). EcoTransIT is an acronym of the “**Eco**logical **Trans**port and **IT**” project, which was originally confined to calculate and compare the environmental impact of transport modes operating in Europe. New partners have subsequently joined: Red Nacional de los Ferrocarriles Españoles (RENFE), Société Nationale des Chemins de Fer Belges (SNCB) and DB Schenker. All project partners provide information for the database and constantly update the tool according to national policies and available state-of-the-art information through the Advisory Body which currently consists of Oeko-Institut e.V., Berlin and IFEU Institute, Heidelberg (see website at: www.ecotransit.org).

The EcotransIT World Consortium officially opens its gates beginning of 2011 with a Stakeholder Workshop on October 5, 2010. It shall be expanded by all interested stakeholders of the transport industry who wish to use and further develop a commonly operable tool which embraces the standardization procedure for emission calculations.

EcoTransIT identifies the environmental impacts of freight transportation in terms of direct energy consumption and emissions during the operation of vehicles involved in freight transport (tank-to-wheel). Moreover, the calculation covers the indirect energy consumption and emissions related to the production, transportation and distribution of energy required for operating the vehicles (well-to-tank). There are many factors that determine the level of the environmental impacts in freight transport. An exhaustive array of influencing factors serves as the basis for computing impacts. This allows the user to alter the factors of the EcoTransIT application according to a stakeholder's individual conditions.

4.6.2 The methodological framework

The methodology of the tool is described in detail in a background report to be downloaded from: http://www.ecotransit.org/download/ecotransit_background_report.pdf

The backbone of the tool is a comprehensive geo-mapping of the transport infrastructure and a maximum coverage of locations globally.

4.6.2.1 Routing

- Locations: ca. 850,000 places and 222,600 zip codes
- Roads: 8 million road kilometers
- Rail: 37,500 rail stations, 1.3 million rail track kilometers
- Inland waterways: 550 inland water ports
- Ocean shipping: 7,265 ocean ports, thereof 79 large container ports, 168 medium and 370 small container ports, and 6,650 minor ports
- Airports: 964 airports

The routing algorithm reflects the actual flow of goods according to the major national and international hubs. It also reflects the allocation of the ocean vessel and aircraft world fleet. In ocean shipping the navigability of ports and sea routes such as the Kattegat, the Suez Canal, Panama Canal etc. is considered, in rail transports the different track systems (track gauges) and in road transports the different road categories and topographies whereby highways are preferred by a certain “resistance” factor to other road categories.

The route distances are constituted by the actual geographic route, whereby in air and ocean transports an additional correction factor is applied for route deviations, in ocean shipping the weather conditions and string scheduling, in air transports the movements of take-off and landing are taken into account.

4.6.2.2 Road emissions

The calculation of road emissions depends on the following key parameters:

- Size of vehicle
- Emission class of vehicle (age of vehicle)
- Load factor of vehicle
- Empty trips
- Cargo mix (volume, average, heavy)
- Topography (flat, hilly, mountainous)
- Road category (highway, country road, urban)
- Fuel quality (bio-fuel share).

These parameters are well researched in Europe (HBEFA/Artemis) and in the U.S. (MOVES). Five European and Japanese, and five U.S. size classes are considered in EcotransIT World along with five prevailing emission classes (Euro class, EPA classes and JP classes).

Biodiesel blends are not considered yet but in the scope of the next step of development, whereby a comprehensive database of biodiesel sources has to be researched.

4.6.2.3 Rail transport emissions

The data set for rail emissions is based on ca. 200,000 rail transports of DB Railion (currently: DB Schenker Rail), analysis of SBB rail transports, annual average data of many European rail companies, of the UIC energy database, as well as from American and Canadian rail companies. Energy consumption data of rail transports in China are also taken into consideration. The parameters involved in rail emission calculations are:

- Size of train (length)
- Electrification
- Source of electricity (per country)
- Load Factor
- Cargo mix
- Empty trips
- Topography

Default values for all these factors have been calculated based on the rail statistics mentioned above.

4.6.2.4 Air transport emissions

The data set for air transport emissions is based on the EMEP/CORINAIR Emission Inventory Guidebook (Copenhagen, 2006) and the DLR (German Aviation Agency) database. Parameters involved in air transport emission calculations include:

- Size of aircraft
- Age of aircraft
- Type of aircraft (freighter or passenger aircraft/belly freight)
- Load factor
- Distance (take-off and landing require extra energy, also stops for refilling)
- RFI factor

Default values for all these factors have been calculated based on the air statistics mentioned above. For short, medium and long haul transports, a standard "hybrid plane" has been created which represents the statistical mix of aircrafts (in type, age and size) on such routes.

4.6.2.5 Ocean transport emissions

The database for ocean vessel emissions is sourced from the International Maritime Organization (IMO), the Lloyds Shipping Register and the US Environmental Protection Agency (EPA). The relevant parameters include:

- Vessel size
- Vessel age
- Vessel type (containership, bulk carrier, etc.)
- Design speed (main engine speed/capacity)

- Actual speed (main engine speed reduction)
- Load factor
- SECAs (Sulphur Emission Control Areas)

All these factors are taken into account based on abovementioned ocean vessel statistics. 3 size classes of general cargo ships, 6 classes of bulk ships, 7 tanker sizes and 6 classes of container vessels are profiled and mixed according to their statistical route allocation.

4.6.2.6 Inland waterways

Calculations of inland vessels' emissions are based on the same parameters as ocean vessels:

- Vessel size
- Vessel age
- Vessel type (container, bulk etc.)
- Design speed (main engine speed/capacity)
- Actual speed (main engine speed reduction)
- Load factor
- Current direction
- Draft

A bottom-up modelling based on assumptions for each vessel class was used.

EcoTransIT World faces the challenge to cover the entire world. There are only few waterways worldwide that are considered in EcoTransIT World. The majority of waterways are in Europe. Most prominent are the rivers Danube, Elbe, Rhine, and Seine which are at least in sections categorized as class VI according to the UNECE code for inland waterways. Other rivers and canals in Europe are of class V or smaller. All European waterways class IV and higher are included in EcoTransIT World. EcoTransIT World enables inland waterways calculation on the largest of the global waterways, such as the Mississippi, Yangtze, Ganges and Amazon. Worldwide, approximately 50 countries have navigable waterways of more than 1,000 km in length. However, inland freight navigation is underdeveloped in most countries.

4.6.2.7 The calculation levels and modes

The emission calculation in EcotransIT World is "distance-based" according to the Greenhouse Gas Protocol and ISO 14064-1. This means that the allocation of transport emissions is calculated by a multiplication of distance, load tonnage and an emission factor which reflects the above mentioned parameters for all modes of transports in a transparent way.

4.6.2.8 Standard or Extended

The calculation levels are "Standard" and "Extended". In the standard mode, the current industry level is reflected as closely as possible, whereby an annual update is implemented by the scientific Advisory Committee of the consortium.

The Extended mode shows all default parameters which can be modified by the user according to the actual conditions prevailing in the specific application.

The user has the option to select between truck size classes, truck emission classes, 31 aircraft types, 22 vessel sizes and types, can select the load factor, empty trip factor, speed reduction (ocean shipping) and the consideration of the RFI factor in air transports.

4.6.2.9 Supply chain calculation and transport mode comparison

Each transport route can be tailor-made by transport leg and mode including the definition of cross-docking (which is also included in the calculation).

The same route can be compared to another modal split as per definition. All modes of transport can be selected individually.

4.6.3 Reports

The report profile can be selected among 4 different modes of data overview, which include a Google Map visualization of the actual routing. The following emissions are shown in 3 different energy units:

- CO_2
- CO_2eq
- NOx
- SOx
- NMHC
- PM

4.7 The "Calculation of external costs for goods transport" project

The project was carried out at IVL with financial support by Vinnova, the Centre for Environmental Assessment of Products and Material (CPM) at Chalmers University and the Foundation for the Swedish Environmental Research Institute (SIVL). The member companies at CPM which co-financed the project were Schenker, Akzo Nobel, ABB and AB Volvo.

4.7.1 Definition

The external costs, also referred to as negative externalities, are in general paid by society in contrast to the internal costs, such as costs for fuel, driver salaries, vehicle repair, road toll etc, which are paid by the transport provider and thus ultimately by their customers. In many cases it is difficult to establish exactly which part of the costs is external respectively internal. For example, congestion costs are paid by everyone getting caught in traffic through loss of productive time while waiting. However, these costs also strike the road carriers through delays and extra costs for wages etc. Accident costs are usually borne primarily by society but may also partly be covered by insurance fees. When it comes to air pollution, these costs are normally paid by society in general but sometimes also by individuals, like farmers and owners of buildings. The problem with external costs often arises because of market failures. Market failures occur because markets for environmental goods and services usually do not exist, or when the markets do exist, the market prices underestimate their social scarcity values.

4.7.2 Estimation of external costs

The methods to calculate external costs are in general based on the following simplified formula:

*External cost = unit cost * degree of harm * intensity * volume*

In the case of transport, volume means vehicle kilometres or passenger-/ tonne-kilometres performed by a certain mode of transport. Intensity (of effect) is the physical measure of the effect relative to transport volume, e.g. emission of SO2 per vehicle kilometre. Degree of harm (degree of damage) is related to the size of the effect, e.g. number of deaths or cases of illness due to emission of particles. The unit cost (of harm) is the cost that is inflicted on society resulting from certain 'harm', e.g. the cost per death or per case of illness.

External costs from the transport sector are estimated in different ways. However, the most used method today to assess transport externalities associated with emissions is the impact pathway approach. The most important substances normally considered are nitrogen oxides (NOX), particulate matter (PM), volatile organic compounds (VOC), carbon monoxide (CO) and the secondary pollutant ozone (O3). Typically, health risks are most important but also the impact on ecosystems (acidification, eutrophication etc) and corrosion are important. The treatment of these effects is similar for all transport modes, although the location of the emission is of course very different and must be considered.

4.7.3 Description of the tool

The tool calculates the emissions and the external costs for a specific goods transport alternative. Such an alternative may comprise a number of routes, i.e. the goods may be transported by different vehicles or transport modes on different parts of the total distance. The user must give a set of data for routes, cargo and vehicles. The external costs typically vary with the site. In the tool we have chosen to have two levels, urban and non-urban areas. Thus, the user is required to indicate the fraction of each route that runs in urban areas. The load factor is essential for correct calculations and should be related to the transported goods.

There are a number of different values for external costs in the literature. The tool mainly contains data from Maibach et al. (2008). However, in the tool there is a possibility to choose between costs for "mitigation" and costs for "impact". This applies only to the emissions and is most important for the green-house gases (GHG). The mitigation costs are the costs for avoiding the emission. The impact costs are the costs for society for dealing with negative effects. In the tool there are three levels of values (max, mid, min) for each parameter and calculations are made for all three levels in order to illustrate the uncertainty in the method.

The tool is intended to calculate external costs and is not primarily a tool for calculating emissions. However, the latter is needed within the tool and is included following the principles of the Network for Transport and Environment (NTM, 2009). The number of vessels and vehicle types is limited basically to what is found in the NTM documents and, for road, in the Artemis model. In addition, a number of vessels/vehicles have been added since they were needed in the different case studies. The distances for each route are to be given by the user.

4.7.4 Emission calculations

The emissions for each route are calculated from the emission factor for the chosen vehicle, the distance given, the amount of goods and the given load factor. In the tool we use emission factors expressed as mass of emissions per travelled distance and load (in g/tonne-km). The actual emission factor in per tonne-km is then obtained by dividing the emission factor for the vehicle with the load factor. A special situation is at hand for airplanes. Here the emission factors are divided into one for each landing and take-off (LTO), given in kg emission per tonne freight and one for the remaining flight given in g per tonne-km. The tool automatically switches between mass and volume depending on the data given by the user. The density where this switch occurs depends on the transport mode.

The emission of GHG is given in CO2-equivalents. The impact on global warming from the emission of particles and from the formation of secondary pollutants is not included in the model.

4.7.5 External costs calculations

The calculations of external costs for the emissions and the use of fossil fuel are done by multiplying the emissions for a route with the values for the external costs in € per mass unit of the respective substance. The tool contains these external costs divided in urban and non-urban values. The fraction of the emission that is multiplied with the respective value is obtained through the urban factor given by the user for each route. The values for the external costs are taken mainly from Maibach et al. (2008) and Steen (2000).

The costs for noise, congestions, up- and downstream, nature, soil and water, and accidents are calculated based on a list with values in € per distance travelled for a vehicle/vessel. For airplanes these costs typically occur during take-off and landing. The tool thus calculates a cost using values in € per flight for each of these external cost categories.

4.7.6 Results

An immediate value of the tool is that it serves as an eye-opener. The actual values for the external costs can be compared with the internal costs and the potential for future internalisations can be estimated. The tool is very illustrative in comparing different alternatives for transporting a specific set of goods.

The main uncertainty in the calculations lies in the estimation of external costs in € per tonne-km or € per kg of emission. A number of parameters should be given by the user. Sometimes the type of vehicle used is not known in detail which leads to uncertainties in the results. The load factor is often even harder to establish. Another often unknown factor, the urban fraction, poses a further problem.

The external costs for emission of particles will vary strongly between sites depending on the population density of a specific location. In the tool we only have values divided into urban and non-urban locations. In principle the tool could be extended with cost tables covering different regions in much more detail. The user would then have to specify the regions in detail.

It is not straightforward to assess which part of the costs associated with negative impacts are already internalised. The taxes and fees charged in the transport sector are often motivated by infrastructure cost. One may also note that the policy measures taken as well as the levels of fees and taxes are usually not motivated by the actual external costs that should be internalised.

4.8 Transport cost calculators

A number of previous studies reported serious difficulties in collecting transport cost information. The alternative is then to use a model calculating transport costs. Two SuperGreen partners have developed such calculators for internal use; one of them has even upgraded their tool especially for the needs of this project. Two more cost calculators were found in the literature reviewed. All these calculators are briefly presented under this heading. The selection among them will be made after their formal assessment.

4.8.1 The COMPASS tool

IHS Fairplay developed a tool within project MOSES (Motorways of the Seas European Style). MOSES was terminated, but IHS Fairplay continued developing the tool at its own expense.

The tool is named "COMPASS", which is an acronym for comparison tool for co-modal transport assessments. COMPASS enables the entire transport chain to be modelled in steps and activities. Each transport chain can be setup with as many nodes and links as is required. The output will give a description of the transport by:

- the total direct cost for the transport (operational cost),
- the time to produce the transport, and
- the total socioeconomic costs to produce the transport.

COMPASS can be used to benchmark different transport solutions, to find the cost relation between different transport systems, and to select the most favourable transport alternative.

COMPASS is built in Microsoft Access format. The country data as well as vehicle data can be stored to be reused or adjusted/edited and used. In this way it has a generic function that builds up when it is used. Some typical load carriers and vehicles are present at start. New specified load carriers and related information can be fed in to be stored and used. Also cost levels and other specifications of vehicles or performance of vehicles or fuels may be stored in the application.

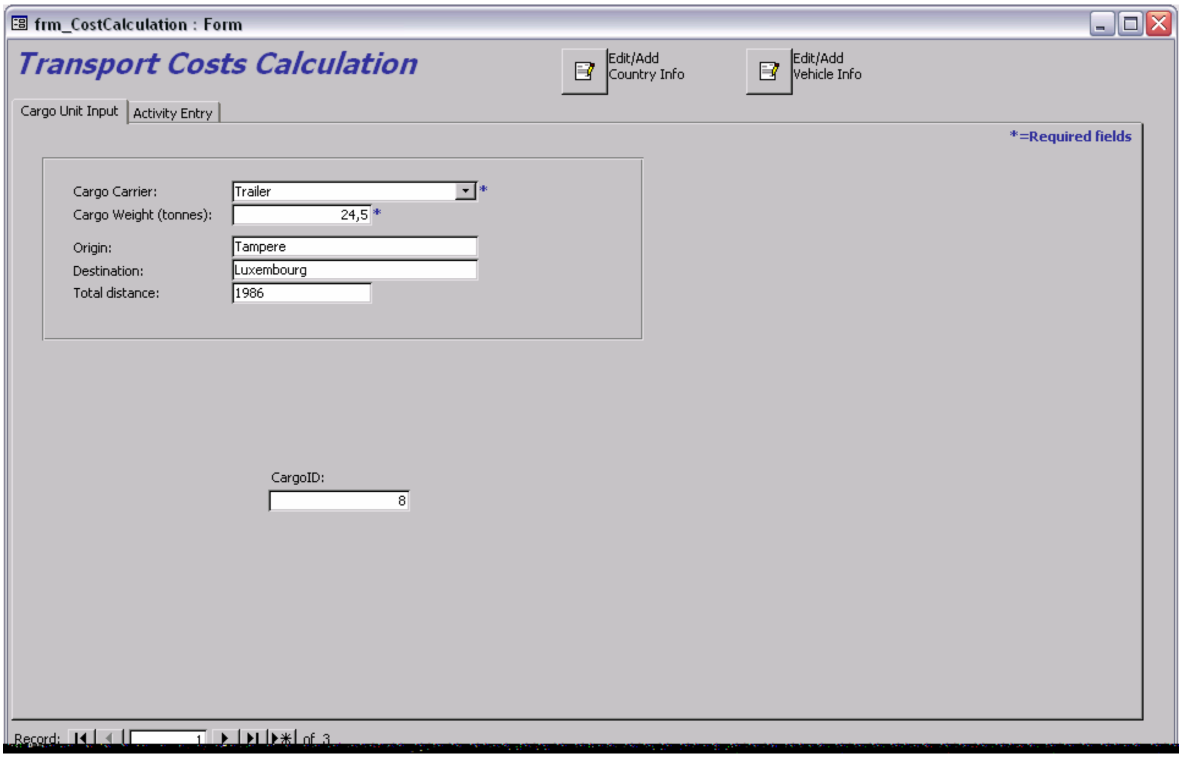

Figure 8. COMPASS - Input of basic cargo unit data (Source: IHS Fairplay)

In the first form the basics of the transport are given mainly providing the type of load carrier and the transport relation.

Country specific data and data of vehicles used are entered in the following step. Country specific data concern: vehicle performance, cost of fuels, type and specification of fuel used, damage costs of emissions and other relevant cost factors.

In this box the German Maut may be entered and similar effects of charged or non charged costs can be tested.

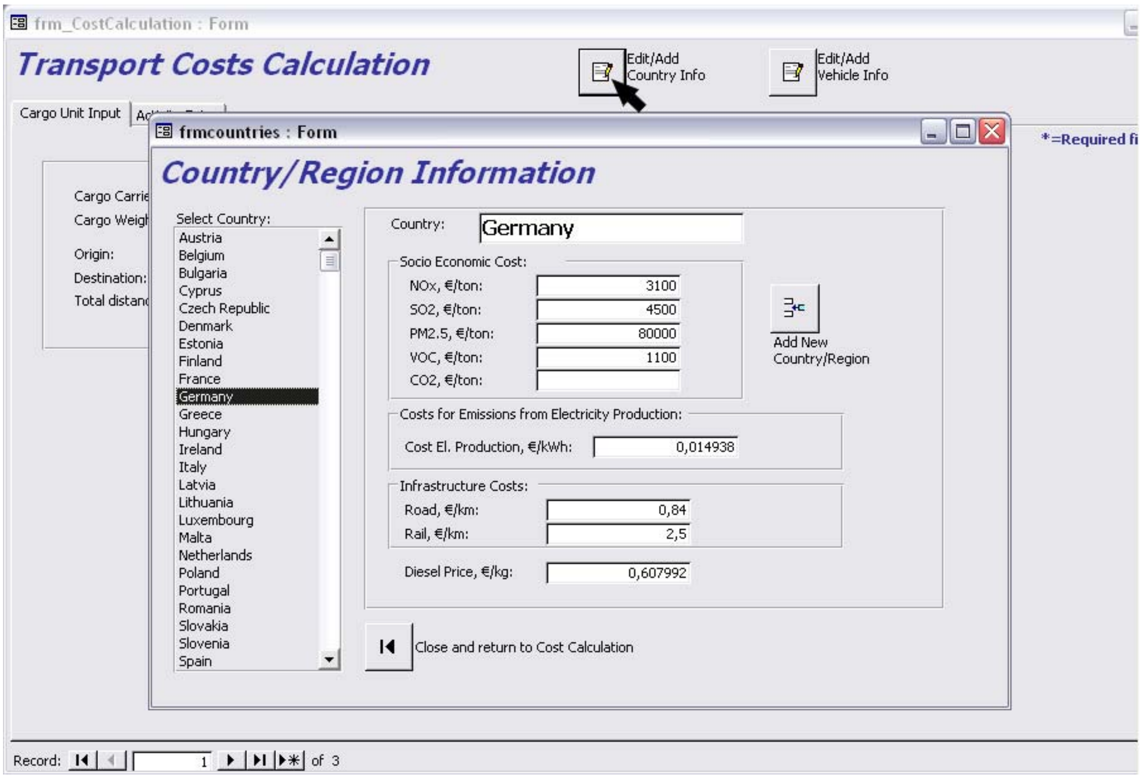

Figure 9. COMPASS - Input of country specific data (Source: IHS Fairplay)

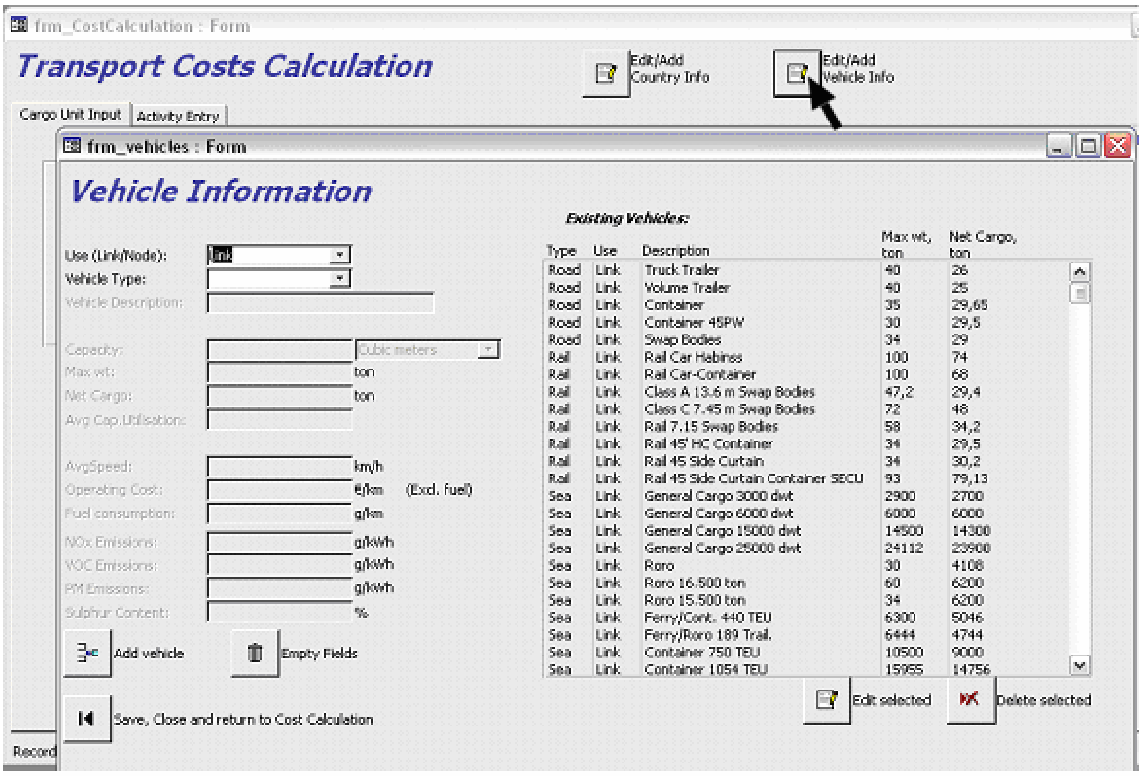

Figure 10. COMPASS - Add new vehicle (Source: IHS Fairplay)

Next step is to specify the vehicle used in the transport. This can be chosen from vehicles previously stored in the vehicle database, edited or created in the Edit/Add Vehicle info form.

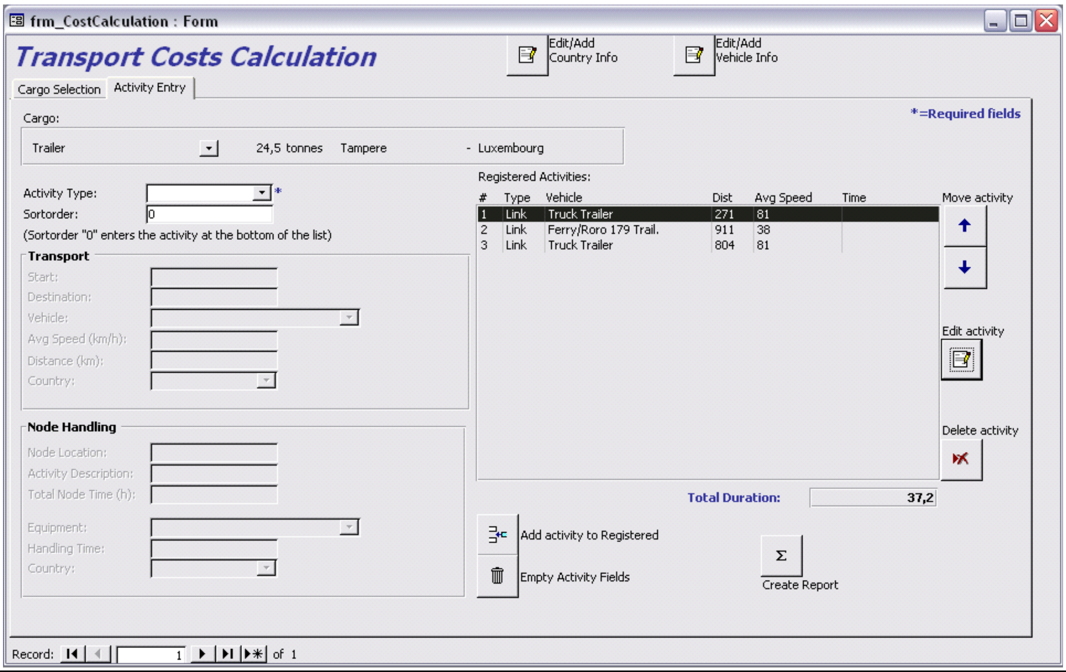

Figure 11. **COMPASS - Build the supply chain (Source: IHS Fairplay)**

With the form “Transport Costs Calculation” the supply chain is entered with the nodes and links separated.

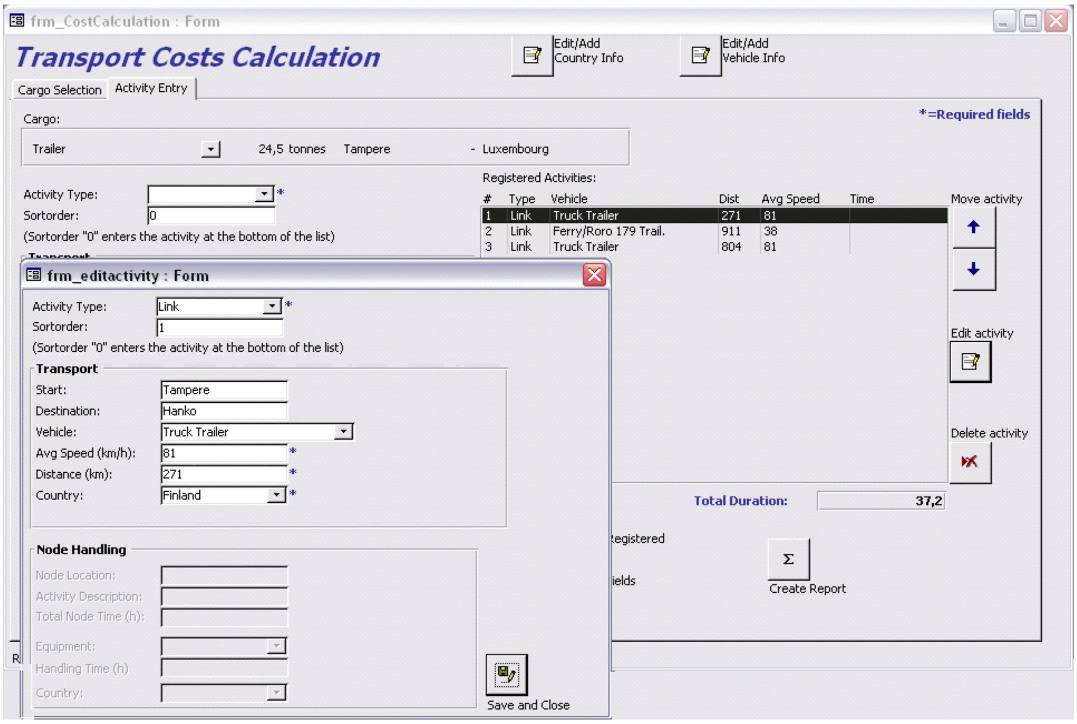

Figure 12. COMPASS - Each link could be edited separately if needed

The link activity is described as the start location of the transport, the destination and the type of vehicle used to transport the cargo carrier. Finally the average speed is entered as well as the length of the specific link.

A link cannot extend longer than to the border of a country, after which a new link has to start. A link will always go between two positions while a node is an activity that occurs in one position. The tool will automatically use the cost level related to the country assigned to the link.

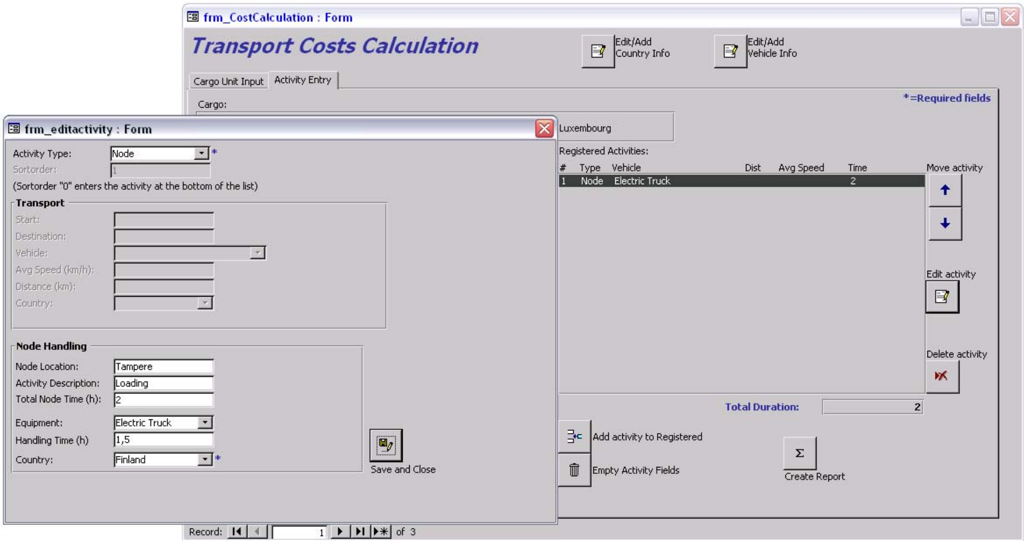

Figure 13. COMPASS - The activity in each node can be edited separately

Once all relevant data is registered a report can be created. The report gives the total list of activities and the result of the activity.

Table 5 is a sample output from the analysis of a supply chain in COMPASS. The model could quite easily be extended to include a selection of KPIs.

Table 5. Illustration of output from COMPASS

Evaluation of Costs for Transport Chain

CargoType:

Quantity:

Origin:

Destination:

ActivityType:	Node	**Start:**	Tampere	**Dist, km (NM at sea):**	
Description:	Loading	**Destination:**		**Duration, h:**	2
Vehicle:	Electric Truck	**Country:**	Finland	**Direct Costs, €:**	
				Emission Costs, € :	2
ActivityType:	Link	**Start:**	Tampere	**Dist, km (NM at sea):**	271
Description:		**Destination:**	Hanko	**Duration, h:**	4
Vehicle:	Truck Trailer	**Country:**	Finland	**Direct Costs, €:**	592
				Emission Costs, € :	15
ActivityType:	Node	**Start:**	Hanko	**Dist, km (NM at sea):**	
Description:	Port Terminal	**Destination:**		**Duration, h:**	1
Vehicle:	Terminal Tractor	**Country:**	Finland	**Direct Costs, €:**	4,1
				Emission Costs, € :	0
ActivityType:	Link	**Start:**	Hanko	**Dist, km (NM at sea):**	492
Description:		**Destination:**	Rostock	**Duration, h:**	24
Vehicle:	Ferry/Roro 189 Trail.	**Country:**	Baltic Sea	**Direct Costs, €:**	229
				Emission Costs, € :	472
ActivityType:	Node	**Start:**	Rostock	**Dist, km (NM at sea):**	
Description:	Terminal handling	**Destination:**		**Duration, h:**	3
Vehicle:	Terminal Tractor	**Country:**	Germany	**Direct Costs, €:**	2,7
				Emission Costs, € :	1
ActivityType:	Link	**Start:**	Rostock	**Dist, km (NM at sea):**	804
Description:		**Destination:**	Luxemburg	**Duration, h:**	12
Vehicle:	Truck Trailer	**Country:**	Germany	**Direct Costs, €:**	1762
				Emission Costs, € :	114
ActivityType:	Node	**Start:**	Luxembourg	**Dist, km (NM at sea):**	
Description:	Discharge trailer	**Destination:**		**Duration, h:**	2
Vehicle:	Electric Truck	**Country:**	Luxembourg	**Direct Costs, €:**	
				Emission Costs, € :	1
ActivityType:	Link	**Start:**	Luxemburg	**Dist, km (NM at sea):**	231
Description:		**Destination:**	Hamburg	**Duration, h:**	3
Vehicle:	Truck Trailer	**Country:**	Germany	**Direct Costs, €:**	506
				Emission Costs, € :	33
ActivityType:	Node	**Start:**	Hamburg	**Dist, km (NM at sea):**	
Description:	Repositioning	**Destination:**		**Duration, h:**	6
Vehicle:	Diesel truck	**Country:**	Germany	**Direct Costs, €:**	
				Emission Costs, € :	0
ActivityType:		**Start:**		**Dist, km (NM at sea):**	**1798**

4.8.2 The NP Should calculator

4.8.2.1 Introduction

The NP Should cost calculator was developed internally in Procter & Gamble in the framework of the 2009 internship program. The tool estimates transport costs, lead times and external costs. Calculations are made based on collected data, which are linked to a user specified intermodal transport chain.

The model was improved by the developer in 2010 in terms of number of countries, infrastructure objects and modes of transport (e.g. inland waterways) covered. These improvements were made in order to benchmark the SuperGreen corridors as an internal project in Procter & Gamble, the leading partner of Task 2.4 (Benchmarking of Green Corridors).

The tool is owned by Procter & Gamble but, in the case it is finally selected for use under the SuperGreen project, it can be made public and available free of charge. Otherwise the tool will remain restricted and shall be used only by its developer.

The NP Should calculator is a MS Excel based tool which can estimate the following indicators:

- Average cost in €/TEU
- Average lead time in hours
- Total external costs in €/TEU

4.8.2.2 Model input and output

Calculations can be made for the intra-EU intermodal transportation considering country specific data, like fuel price, infrastructure fees and cost of labour, etc. Currently the model covers 13 European countries, including Central Europe, Nordic countries, the UK and the Mediterranean area. An average default unit value (per km) is used for countries not covered. The system can also take into consideration working time limitations in road transport and time delays due to gauge differences in rail transport.

The user describes the route to be examined by specifying:

- the route segments,
- the distance of each segment,
- the mode used in each segment,
- the node type (seaports, inland navigation terminals or inland bi-modal road-rail terminals),
- the use of special infrastructures as the Eurochannel, the Oresund Bridge, the Tunnel du Fréjus or the Tunnel du Mont Blanc

and some other variables like:

- the load factor,
- the average number of wagons per train, and
- the current fuel prices, as provided in the website http://www.energy.eu/#prices.

The model has the ability to compare user specified input against acceptable ranges in order to identify potential mistakes. The user has the ability to modify all default values used by the model.

External costs are calculated based on an average unit figure of 0.035 €/tkm for trucks, 0.015 €/tkm for rail and 0.009 €/tkm for ships.

Accuracy tests of the model results run internally by Procter & Gamble, have shown deviations from real costs in the range of 5-10% for road transport. Deviations for rail transport were higher (10-50%) due to lower visibility of cost structures in this sector. No accuracy tests have been run so far for inland waterway transport and short sea shipping, modes for which the background information on costs and cost structures need to be updated.

4.8.3 The IMTIS calculator for combined transport with CO_2 emissions

The German company Contargo is specialized in tri-modal container logistics. Since 1996 they have developed an "Intermodal Tariff Information System" (IMTIS), which helps clients with evaluating the best transport mode and route. The system is permanently being updated and by now possesses knowledge of more than 115,000 destinations in Europe. In 2007, the calculator was extended by a new factor: the CO_2 emissions of each mode of transport. The system is easy to handle as you only need to enter the name of the seaport and the destination in the hinterland: the programme will suggest a route by means of combined transport, also including CO_2 emissions. Thus, a comparison of the environmental friendliness of barge, train and truck is possible.

IMTIS acknowledges a variety of factors in its calculations, i.e. if a ship travels up- or downstream, if the carriers need to travel with an empty container, the consumption relating to loading and unloading in the terminals and many more.

The tool can be downloaded for free after registration under www.contargo.net/services.

4.8.4 The GIFT model

A similar tool is GIFT, an acronym for Geospatial Intermodal Freight Transportation. It enables trade-off case studies between economic, environmental and energy impacts of freight transportation. GIFT has been developed as a joint project between the University of Delaware and Rochester Institute of Technology.

GIFT has been applied on a number of North American projects such as for East Coast freight studies and for the Great Lakes region. In the latter project, implications of policies such as a carbon tax introduction were studied, as was the impact of infrastructure investment.

The data flow for GIFT analysis includes the following steps:

- Freight transportation data
  - transportation network geospatial data
  - vehicle and facility emissions and operations data
  - freight flow data
- Scenario configuration data
  - network configuration
  - vehicle and facility selection and characterization
  - freight flow selection and characterization
- Scenario data comparison and analysis for case studies
- Scenario analysis results.

5 Best practices in logistics

This section discusses projects whose objectives are to identify best practices in logistics, to the extent they are relevant to SuperGreen.

5.1 The PROMIT project

PROMIT is the acronym of the “Promoting Innovative Intermodal Freight Transport” Coordination Action, funded by the European Commission under the 6th Framework Programme. It fosters the development of intermodal logistics through the promotion of successful logistics approaches to intermodal transport solutions.

In the report “Best Practice Year 1, 2 and 3” (Deliverable D 3.1 – 3.3) of April 2009[13], the project team presents 35 good/best practice cases selected out of a total of 83 cases studied. They have been sourced through European research projects (e.g. FP 5, 6, Interreg), European consulting projects (e.g. ISIC), European intermodal support programmes (e.g. PACT, Marco Polo I), the EIA Intermodal Awards from the last 5 years, publications of business associations and private actors, the workshops organized by the project, own projects of partners and subcontractors, national programmes of the Member States, transport journals and newspapers, and the EURIFT database. The cases are presented in four clusters: Organization and business models, Intermodal infrastructure and equipment, Information and communication technology, and Intermodal operation and services.

The following six cases are the most interesting ones from the SuperGreen perspective.

5.1.1 BRAVO

The Brenner corridor is one of the busiest European freight corridors both by road and rail, which is transiting the sensitive Alpine region. With an objective to raise the volume of environment-friendly combined rail-road transport and increase rail’s market share on the

[13] http://www.promit-project.net/UploadedFiles/Deliverables/PROMIT_BPH3_April09_cp_MSR.pdf

Figure 14. Brenner Corridor (Source: KombiConsult)

Brenner corridor, in 2002, all stakeholders of this industry from Austria, Germany and Italy committed themselves towards the Ministries of Transport of the countries in question to the "Action Plan Brenner 2005".

This plan contains a list of measures required to organize and ensure the short- to medium-term upgrading of the level of service provided in combined transport on this corridor. It takes up existing measures and projects improving the competitiveness of rail freight. It consolidates these approaches, supplements them by additional actions, and supports them by means of an implementation plan that is aimed at bringing about a modal shift.

The objectives of the BRAVO project were:

- Development of a coherent open corridor management scheme including: (1) improvement and intensification of cooperation between the railway undertakings and infrastructure managers, (2) improvement of communication and data exchange to optimize the interfaces between parties involved, and (3) introduction of an overall quality system and a removal of operational bottlenecks.
- Interoperable rail traction involving multi-current locomotives and including train path re-scheduling, simplification and harmonization of locomotive approval procedures (certification).
- Development of a comprehensive quality management system including a standard quality agreement and a quality manual. Within this manual, processes are described in a standardized way. The quality indicators identified as relevant and their corresponding goals set are presented in Table 6.
- Development of an advanced monitoring and customer information system providing regular information of train position on the entire train journey and event-based information as irregularities and their impact (estimated time of arrival, estimated time of availability).
- Scheme on extended and innovative intermodal services including time-table tool.

- Development and demonstration of a new technology to capture conventional semitrailers for unaccompanied intermodal transport, including adaptations at the wagons and simple construction of additional handling equipment without additional large scale infrastructure.

Table 6. Defined quality objectives (Source: KombiConsult)

Punctuality	90% (with max tolerance of 15 min)
Reliability	Max train delay of 180 min (related to 10% of non punctual trains)
Flexibility	Cancellation of regular trains up to 48 hours prior departure without extra charge Interim time-table modifications within three months after submittal of request
Customer information	Real time monitoring of every train Reporting of ETA Co-ordinated international reporting system
Rolling stock	95% rate of employment of agreed wagon set
Documents	99.9% rate of reliability of transport of accompanying documents

The implemented measures of the project exhibit very positive results:

- Increase of traffic on railway within the corridor (+16% p.a.).
- Modal shift: 5.92 to 6.86 million gross tonnes from 2005 to 2006.
- Quality improvements in terms of reliability, flexibility, enhanced customer satisfaction and reliability of transport documents.
- Benefits for environment and traffic on Brenner road.

The key success factors were:

- the corridor approach followed,
- the fact that all main operators of the corridor joined the project, as cooperation was necessary to deal with a bottleneck that was inconvenient and challenging for all, and
- the fact that focus was placed on quality and customer satisfaction.

The project results offer many transferability opportunities, as the project was designed to function as a blueprint applicable to other European corridors as well.

5.1.2 RODER and AlpFRail

This is a successful supply chain logistics case exhibiting the synergies between two separate developments, presented as distinct good/best practice examples in PROMIT. It concerns freight traffic between Turkey and Western Europe. The existing land-based road routes were already unattractive in respect to distance, time, transport costs and environmental impact, especially due to the poor prevailing road conditions and the long time required for clearing the numerous border crossings. The internal conflicts in former Yugoslavia further worsened the situation.

In 2001, the RODER company was founded to develop the combined transport services between Turkey and Europe through short sea shipping, initiated as early as 1994 by a group of transport operators. The immediate targets were:

- avoidance of traffic pressures on main transport routes,
- reduction of operational costs,
- limiting capital investment on trucks, and
- reduction of emissions and noise.

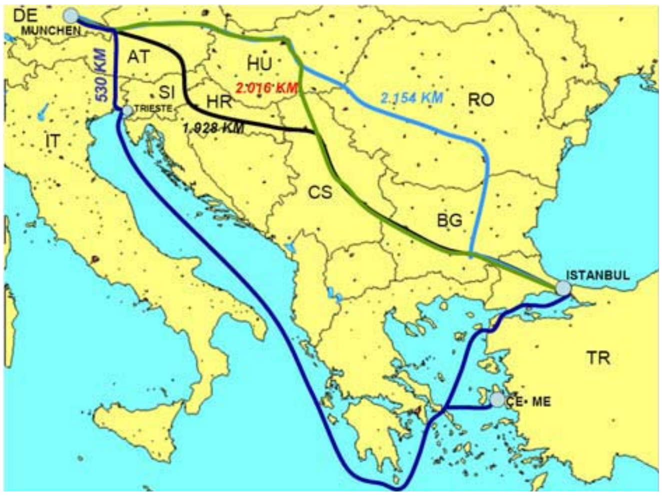

Figure 15. Transport routes from Turkey to southern Germany (Source: Roder)

The intermodal transport chain is organized as follows:

- **Road transport:** Cargo is picked up from various inland locations in Turkey and transported to a RoRo terminal (Pendik, Ambarli or Çeşme).
- **Short sea shipping (unaccompanied transport):** Following customs clearance, the complete units (tractor and semi-trailer coupled) or the uncoupled semi-trailers (tractors are left behind at the terminal) are boarded on RoRo vessels and transshipped to Trieste. Sailing time takes approximately 60 hours. The truck drivers fly from Istanbul to Ljubljana and reach Trieste by bus.
- **Rolling motorway (accompanied transport):** Following unloading and customs clearance at Trieste, a significant share of the trucks are loaded on trains serving the Tauern axis (Trieste-Villach-Salzburg). The journey to Salzburg takes 9 hours. There are 3 departures daily on each direction and the trains can carry 20 transport units. The truck drivers use special sleeping cars of the train.
- **Road transport:** The trucks disembark at the Salzburg rail terminal and continue their journey to their final destination by road.

Figure 16. TrailerTrain on the Tauern axis (Source: PROMIT)

Improvements in rail operations along the Tauern axis are the objective of the AlpFRail (Alpine Freight Railway) project, aiming at a consequent displacement of freight flows to rail in the Alpine region by innovative concepts. Contradicting information on the availability of additional rail paths along the Tauern axis was the starting point to elaborate on train operations. By means of technical and organizational improvements on this axis, additional capacities for up to 18 trains per day can be generated, providing the prerequisite to set up additional services in the framework of the TrailerTrain and AdriaZug initiatives described below.

The TrailerTrain initiative aims to extend the intermodal unaccompanied transport chain of RoRo services from Turkey to Trieste to the Bavaria region by train. The extensive market analysis performed covers both craneable and non-craneable trailers (presently 60% of unaccompanied trailers coming to Trieste are craneable). The port of Trieste provides several alternatives for the transshipment of trailers. Overall 5 existing or future possibilities were analysed, involving transshipment by crane, by using the Modalohr system, and by using RoLa tractors. The scheme would exhibit the following advantages:

- Lower operating costs for the transport operator due to shorter transit time (less than 12 hours as opposed to 14-16 hours of the present solution). As the rail leg is carried out without drivers, about 1 day lower personnel and equipment operation costs can be realized per trip.
- No waiting time for trucks in the terminal for loading and unloading from the train. Employing the RoLa tractors makes the approach independent from the availability of trucks in the receiving area.
- The possibility to cross the Alps also on weekends and bank holidays.
- No resting time for the drivers.
- The customs clearance takes place in the destination (instead of the sea port) leading to additional time savings.

During the project duration of TrailerTrain, the extension to Salzburg via rolling motorway (see above RODER) could be established.

The AdriaZug initiative concerns the rail transport of 20’ and 40’ containers between the container terminal of the port of Trieste and the Munich Riem intermodal terminal. The port of Trieste is served by Evergreen with direct services to Asia and with feeder services to Gioia

Tauro. Evergreen will provide a one-stop-shop for the operation of the train, which will be operated as an “open” train providing capacity to third parties. Transit time is less than 12 hours. As the operation had not started at the time of PROMIT reporting, no price information was available, but calculations were made on the basis of a price equal to that between Munich and the North Sea ports. The scheme would realize time savings of about 4 days between Munich and the sea ports in Asia, while a modal shift of 845 trucks per week is envisioned.

The preliminary results of the AlpFRail project are positive. Within one year, 10 additional trains per day are provided on the Tauern axis, replacing 45,000 truck trips per year. The rolling motorway approach is easily transferable to other European corridors.

5.1.3 STORA ENSO

Stora Enso is an integrated paper, packaging, and forest products company, producing publication and fine paper, packaging board, and wood products; all areas in which the Group is a global market leader. The Group has production facilities in Europe, North and South America, and Asia. Customers include publishers, printing houses and merchants, as well as the packaging, joinery and construction industries, and are mainly concentrated in Europe, North America and Asia.

In order to achieve a demand-driven, quick-response logistics operation, Local Distribution Centres (LDCs) have been established close to customers. The LDCs act as buffers in the supply chain allowing customers to be served immediately upon request. Stora Enso has decided to base the logistics operation on a multi modal supply chain, except in the very few situations where direct truck transport from mill to customer is required for satisfying customer demands. This is because direct truck transport is expensive, as it does not enable the “density of cargo” required for keeping cost at the appropriate level, and given the volumes involved, it would have a significant environmental impact.

In the middle of the 1990’s, Stora Enso initiated a logistics re-organization project targeting at:

- improved customer service,
- reduced cargo vulnerability,
- synergies by integrating the logistical chain of multiple factories,
- reducing transport costs in the logistical chain, and
- reducing environmental impact of Stora Enso transport.

This first project, called Baseport, comprised transport from the mills in Sweden, by train to Gothenburg, the Group’s hub port in Scandinavia, and RoRo shipping to Zeebrügge.

In order to achieve sufficient density of cargo, Stora Enso (in cooperation with the Swedish Railways) developed a weather protected RoRo cassette, the Stora Enso Cargo Unit (SECU), which has a cargo capacity of approximately 80 tons.

Figure 17. A SECU box with containers (Source: PROMIT)

The Baseport transport system is divided into the following set of activities:

1. Stuffing of SECU boxes at the mills. This can be done manually or automatically. Each cargo unit (paper roll being one example) is being assigned a unique identity. Each SECU box also has a unique identity. These identities are being used in a software system providing complete supply chain visibility.
2. Rail transport from mills to the port of Gothenburg via three rail routes; the Dalama, Värmland, and Hylte lines. Swedish Railways had to widen certain tunnels in order to allow SECU box transport.
3. Terminal operation in Gothenburg. This means unloading the trains using a specially designed straddle carrier and carrying the SECU boxes to the marshalling area in the port.
4. The waterborne transport from Gothenburg to Zeebrügge is carried out using three specially designed vessels (the EU project IPSI has developed the vessel design and the concept for cargo handling). The key attribute of these vessels is the rectangular shape of the cargo hold, which enables movement of cargo in and out in straight lanes and loading on two decks simultaneously. The shape of the vessels facilitates very fast cargo handling. Using 6 complete units comprising tractors and translifters, the equivalent of 240 TEUs (4,300 tons) can be loaded in one hour. The shape of the vessels also makes them very versatile, and they may transport a variety of cargo.
5. Loading and unloading in Zeebrügge is also handled by tractors and translifters. Due to the significant difference between low and high tide, a link span has been installed. The port of Zeebrügge functions as a transit centre for Stora Enso to other European inland and local distribution centres, as a centre for ISO container stuffing for the overseas market, as well as an LDC, where goods are stored pending final distribution in Belgium, the Netherlands and Northern France. All cargo except the SECUs is directly transported onwards from the port. The SECUs, however, cannot be transported on European rail due to size limitations and are stripped in Zeebrügge either for onwards transport by rail to LDCs or directly to customers by truck.
6. Final transport to LDCs by rail.

Figure 18. Loading on two decks simultaneously (double ramp) (Source: PROMIT)

After having had operational success with Baseport for a number of years, Stora Enso decided to expand the Baseport concept into the North European Transport Supply System (NETSS). The fleet of vessels has been expanded and new vessels have been designed. Phase 1 of NETSS started in July 2005 and involved the routes: (1) Kotka – Gothenburg, (2) Gothenburg – Tilbury, and (3) Gothenburg – Immingham. Phase 2 started operations in July 2006 introducing the route Kemi/Oulu – Gothenburg – Lübeck.

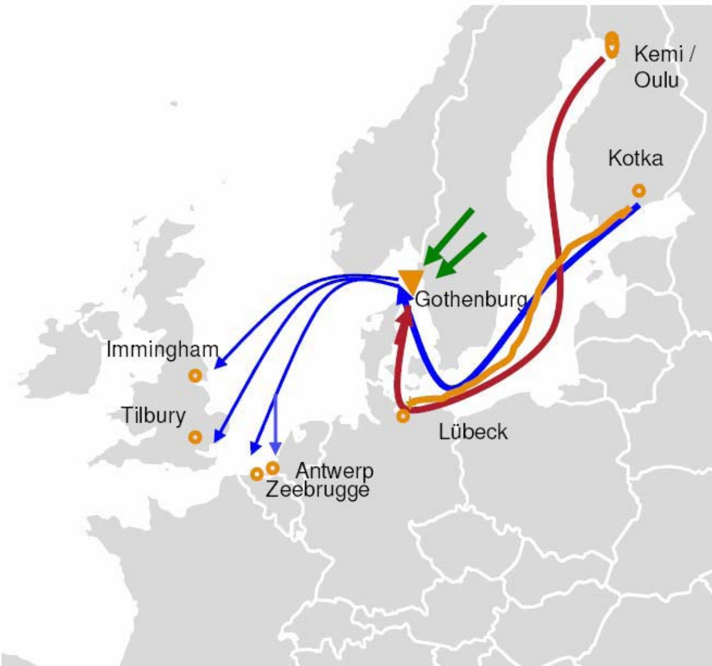

Figure 19. Stora Enso intermodal chains (Source: PROMIT)

The development of services does not stop with the current structure. New connections are planned.

The main success factor for this project was the strategic decisions made by Stora Enso to establish a sustainable transport solution for its products and the determination to carry the project through, despite the hurdles that needed to be passed. The technological developments performed in IPSI, INTEGRATION and other projects were crucial to the success.

The logistics solution conceived by Stora Enso could be a starting point for supply chains in other countries or industrial sectors. The scheme based on Local Distribution Centres is widely applicable. The system can be applied also using ISO containers instead of SECU boxes, not adaptable to European railways.

5.1.4 VOLVO

A train/short sea shipping (SSS) logistics solution has been selected also by Volvo Logistics to cover Volvo's transport needs, although the concept is much simpler than that of Stora Enso. Recognising the fact that Volvo's factories are "peripheral" in relation to customers, the company perceives a distance handicap compared to the other vehicle manufacturers. In practice, these factories have to pay transport costs twice, both for sourcing of materials and for the distribution of finished products.

The objective was to serve the Volvo factories and distribution centres in Umeå, Gothenburg, Olofström/Almhult and Ghent by providing premium transport and sustainable logistics solutions at an optimal cost and with minimum environmental impact. The solution should have the following characteristics:

- At least as fast as the existing system
- More cost effective
- Reliable
- Increasing capacity
- Sustainable
- Combining products (cabs) with production material
- Providing a potential for further development.

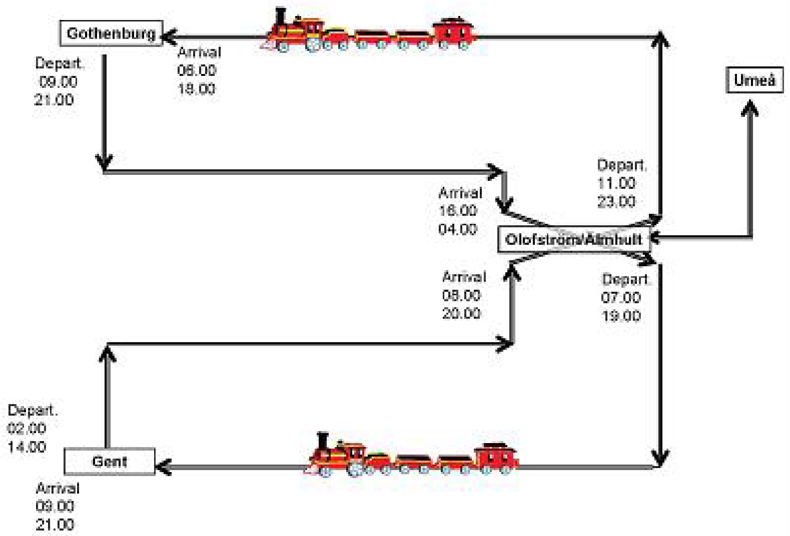

Figure 20. The "8" concept (Source: PROMIT)

The scheme selected comprises of two elements:

- the rail solution, called the "8", and
- the short sea shipping operation, called "EuroBridge".

The "8" operates two trains per day in each direction:

- Olofström-Gothenburg- Olofström
- Olofström/Umeå -Ghent- Olofström/Umeå

Volvo Logistics (VL) acts as the manager of the supply chains, which means that VL is informed by the factories and distribution centres as to what cargo is to be transported and when. VL then interacts with Green Cargo, the train operator who has the complete responsibility to organize transport of cargo from origin to destination. Green Cargo cooperates with Railion Denmark, DB Cargo, Railion the Netherlands, and SNCB (the Belgium Railways).

Transport between Gothenburg and Ghent is crucial to Volvo's operations. As a consequence, a back-up transport solution exists through the SSS operation "EuroBridge" offered by DFDS Tor Line. EuroBridge is a relatively high frequency SSS operation offering 6 sailings between Gothenburg and Ghent per week in each direction. The complete VL transport operation between Sweden and Belgium is shown in Figure 21 below.

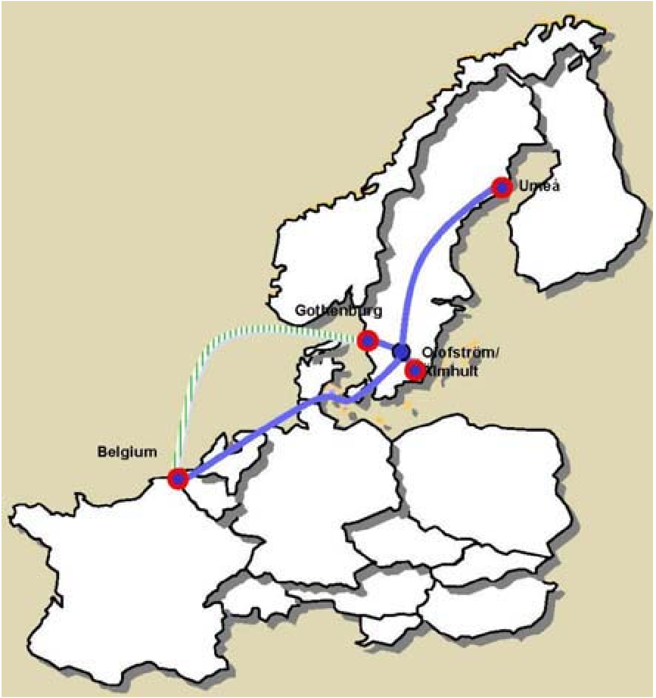

Figure 21. The complete Volvo transport operation (Source: PROMIT)

The contracts concluded between VL and the transport service providers were normal long-term contracts. No contracts were used for the development of the solution. Most of the risk was taken by VL in the form of entering into long-term agreements. The principal investments in new wagons and vessels were made by the transport service providers against the long-term contracts with the customer.

The main strengths of the solution are:

- improved efficiency measured in reduced lead times (using the “8”, the round trip time between Olofström and Gothenburg was reduced from 30 to 20 hours, while the round trip time between Gothenburg and Ghent was reduced from 90 to 64 hours),
- reliability (95% in relation to the time schedule) for a just-in-time production set-up with very little warehousing, this parameter being very important,
- flexibility, as the system is able to handle fluctuations in volumes (carrying different number of wagons),
- robustness achieved by having redundancy between a rail-based operation and one using SSS,
- low cost through high utilization of transport resources, and
- significant environmental gains compared to road only transport.

A weakness (as seen from the transport service providers’ point of view) is that the “8” operation is dedicated to VL cargo only.

The solution has been successfully in operation since 2002. The “8” carried 67,320 containers between Olofström and Gothenburg in 2005. In the same year, 50,660 containers were transported between Gothenburg and Ghent. In addition, the EuroBridge succeeded in reducing the lead time from Gothenburg to Ghent from 42 to 36 hours. The extra time has enabled a service to Brevik, Norway once a week with cars from Ghent. In 2004, 8,804 cars were transported from Ghent to Brevik using EuroBridge. Earlier these cars were first transported to Gothenburg and then to Norway using trucks. As a result of the new schedule of EuroBridge, 1,100 truck movements from Gothenburg to Norway were eliminated.

The solution, as such, is not transferable to other situations, since it is developed for the special needs of Volvo. However, the approach, where a shipper with significant volumes seeks to improve the logistics performance to establish efficient and sustainable solutions, is definitely transferable, as is the business model applied (strategic partnership between shipper and transport service providers).

5.1.5 The Viking Train

The Viking train offers a 1,735 km long link from the Baltic Sea region in Eastern Europe to the Black Sea Region (Caucasus and Turkey) in South-eastern Europe, and beyond to Central Asia. It makes use of the Pan-European corridor IX and circumvents the heavily congested western European north-south corridors, running through the countries of Lithuania, Belarus and Ukraine.

The Viking train as a road-SSS-rail intermodal connection was designed as a RoRo and a LoLo transport solution. RoRo was intended to offer a long distance transport solution for lorries, as the road infrastructure is still inadequate for today's transport needs (e.g. no through motorways, security concerns). LoLo is introduced to offer a link in-between short sea and deep sea shipping on the Baltic and Black Sea and to the Eastern European hinterland. Empty containers can be relocated between northern and southern European regions.

The idea for organizing a passing-through combined transport train (for containers and contrailers) emerged in 1999, after signing of a Memorandum of Understanding by the Lithuanian and the Ukrainian Ministers of Transport and assuming obligations regarding development of transport connections in the Middle Section of Crete Corridor IX. The Belarusian Railways joined the project in 2000.

Figure 22. The Viking shuttle train (Source: PROMIT)

The Viking shuttle train is a joint project of the Lithuanian, Belarusian and Ukrainian railways and train operators, stevedoring companies and the Klaipeda, Odessa, and Iljichiovsk sea harbours. Train operators are Joint Stock Company "Lithuanian Railways", the Ukrainian state transport service Center "LISKI" and the Belarusian national transport forwarding company "Belintertrans".

Freight is transported in 20', 40' and 45' universal and special containers, trailers, trucks and semi-trailers. The shuttle train covers the entire route from Klaipeda to Odessa in 48 hours. Tariffs for container transport by the "Viking" train are considerably lower than the road haulage ones on the same route. Operations are supported by freight carriage management software created by the Lithuanian railways, which is also instrumental in speeding up the customs and border crossing procedures.

The transported volume when the Viking train started in 2003 was 175 TEU. The volume has increased ever since and in 2007 40,066 TEUs were transported. The Viking train is the most successful intermodal train link on the broad gauge network. The basic success factor in this case is the strong political support. The main strength of the concept is the border-crossing one-stop-shop solution.

The concept could be transferred to other international corridors in Eastern Europe and to the East. There are negotiations going on by Lithuanian, Russian and Belarusian railway companies to launch a shuttle train on the route Klaipeda/Kaliningrad-Minsk-Moscow.

5.1.6 Intermodal Terminal in Interporto, Bologna

The terminal is located in the area of the Bologna Freight Village. The multiplicity of railway undertakings operating within the same intermodal terminal, the partial overlapping of the services they provide, and the strong level of competition among them have created the need for improved collaboration and information exchange among market players.

The project in question has the following objectives:

- increase the efficiency of the shunting process,
- optimize the information flow between different actors involved in intermodal transport, and
- increase the capacity of wagons shunted by increasing the capacity of the siding tracks.

They are to be met through the development of an IT system, named ShunTer, which has been integrated to the existing software (T-MOVE). T-MOVE is a web-based application, capable of exchanging data with the systems of the various railway undertakings using the terminal. It handles information concerning train arrival, departure and composition.

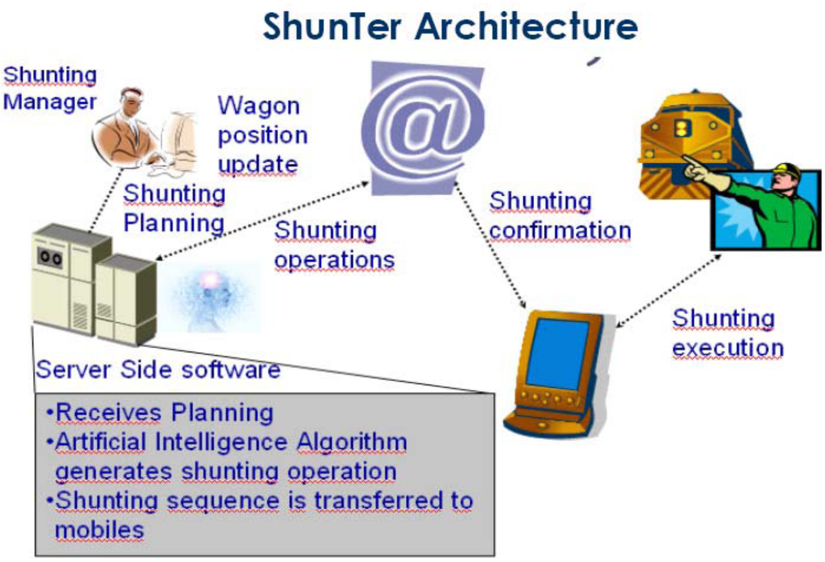

Figure 23. The ShunTer system (Source: PROMIT)

The ShunTer receives from T-MOVE, through the web, information regarding wagon positions and train composition and once ordered by the Shunting Manager, uses an artificial intelligence algorithm to generate shunting sequences, which are transferred to operators through Personal Digital Assistants (PDAs – handheld computers containing instructions for the shunting process) and OBUs mounted on-board the locomotives. The PDA has a touch screen that can be easily used by the shunting operator to receive the shunting orders and confirm the operations concluded.

The system satisfies the following requirements:

- generation of shunting sequences in situations where more than one trains have to be composed,
- setting up priorities for trains,
- minimization of the number of shunting operations,
- consideration of current way in which shunting is performed, and
- consideration of shunting among different terminals inside the same freight village.

At the time of PROMIT reporting the system was partially implemented. The final release was foreseen for the end of 2008. Expected benefits include:

- Higher efficiency through reduction of the number of movements that a locomotive has to perform for completing a shunting order, and thus shortening of the necessary train composition time and reduction of fuel consumption.
- Availability of real time information: The position of each wagon inside the Bologna Freight Village will be monitored in real time, associated with relevant information (type, length, weight, loading status, braking, etc.)
- People managing the shunting processes can have at every instant a snapshot of the real situation of the tracks, allowing an easier management of the shunting process and easier handling of problems.

The project results are directly transferable to other intermodal terminals.

5.2 The PLATINA project

PLATINA is the acronym of the "Platform for the implementation of NAIADES" project, financed by the European Commission under the 7th Framework Programme. Its objective is to accelerate achievement of the NAIADES aims. The NAIADES action plan is a Commission initiative to enhance the use of inland navigation as part of intermodal freight solutions, in order to create a sustainable, competitive and environmentally friendly European wide transport network.

In the "Good practices report II" (Deliverable D1.8) of March 2010[14], the project team presents 87 good practice cases. Among them, the following five are the most interesting ones from the SuperGreen perspective.

5.2.1 ILDE – Intermodal links towards the Danube estuary

The ILDE project examined the feasibility of the development of a cost effective inland navigation connection between Flanders, Romania, Bulgaria, Hungary and Serbia. To overcome the infrastructural problems on the Rhine-Main-Danube corridor, a SSS link between Flanders and the port of Constanta is envisaged, where the cargo will be transferred to barges and shipped to Romanian, Bulgarian, Hungarian and Serbian inland ports.

[14] http://www.naiades.info/platina/downloads

Figure 24. The ILDE concept (Source: PLATINA)

Project actors involve Waterwegen and Zeekanaal NV from Belgium through NV De Scheepvaart, the Port of Ghent, Agro Maas, Fast Lines Belgium, and a number of East-European organisations such as the Port of Constanta, the port of Baja in Hungary, and MainRom Line. Part of the financing for this project is supplied by the Central and Eastern European Fund of the Flemish Ministry for Foreign Policy.

Studies conducted have demonstrated that the project generated considerable interest among parties active in the transport markets. Expediting firms, transporters, shipping companies as well as logistics operators see this project as a catalyst for international cargo development. Several seminars and meetings convinced a number of stakeholders to offer their active cooperation.

These actions have resulted in the birth of the ILDE-Line. ILDE-Line will be operated by “Fast Lines Belgium” in cooperation with “Agro Maas Belgium” and “Mainrom Line”. The target has been set to transfer 600,000 tons/year from road (mainly bulk and general cargo) to IWT and to provide intermodal solutions between the port of Ghent and the port of Constanta.

The trial run of this new shipping line was foreseen for the end of 2008-beginning of 2009, but due to the economic crisis the opening of the line did not take place as scheduled.

5.2.2 Integrated river engineering project on the Danube, east of Vienna

Currently, the free-flowing section of the Danube between Vienna and the Austrian-Slovak border is a major bottleneck for inland navigation because of insufficient fairway depths and strongly varying fairway conditions. This places restraints on the reliability and competitiveness of inland navigation. At the same time the continued deepening of the river bed (erosion) has a sustainable negative impact on the ecological balance of the Danube Floodplain National Park.

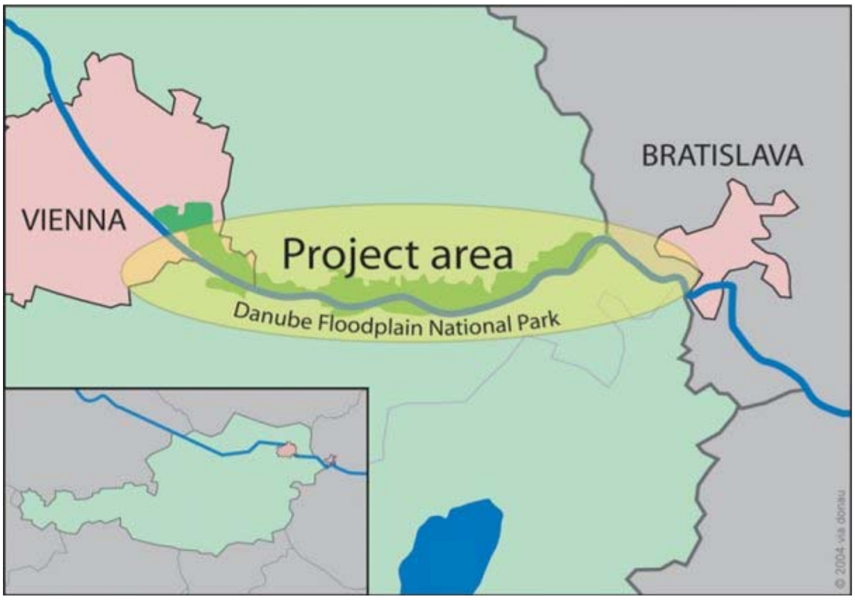

Figure 25. The project area (Source: PLATINA)

In order to tackle these unfavourable conditions the "Integrated River Engineering Project on the Danube East of Vienna" was launched by the Austrian Ministry of Transport, Innovation and Technology and via donau – Österreichische Wasserstraßen-Gesellschaft mbH in 2002. The project aims at:

- securing adequate fairway conditions for inland navigation at low water levels,
- relocating certain sections of the existing navigation channel in order to use deeper zones for navigation purposes,
- stabilizing the river bed by granulometric river bed improvement, and
- reinforcing the landscape-forming power of the river and enhancing the ecological functionality of the whole region by restoring riverbanks and connecting side arms to the main river.

In order to accomplish the project goals, a combination of river engineering and ecological hydro-engineering measures will be carried out at this section of the Danube. After the conclusion of the two-tier Environmental Impact Assessment (EIA), construction works will start. The foreseen engineering techniques are tested within the frame of pilot projects on certain river stretches before full-scale implementation will be achieved. Implementation will last about 9 years following completion of the EIA procedure.

Due to its comprehensive and integrated approach the project forms an important step to cope with growing transport volumes in the Danube corridor in an environmentally friendly way and therefore may serve as a good practice model for the elimination of other, similar bottlenecks along inland waterways.

5.2.3 Canal and fleet development in Finland

The Keitele Canal was built in 1993 with the aim to realize 8m water depth and sufficient overheight to allow feasible transport of timber and other wood products. For several reasons, at that time, the project was not completed. One issue was the fact that the waterway was only accessible in the summer season.

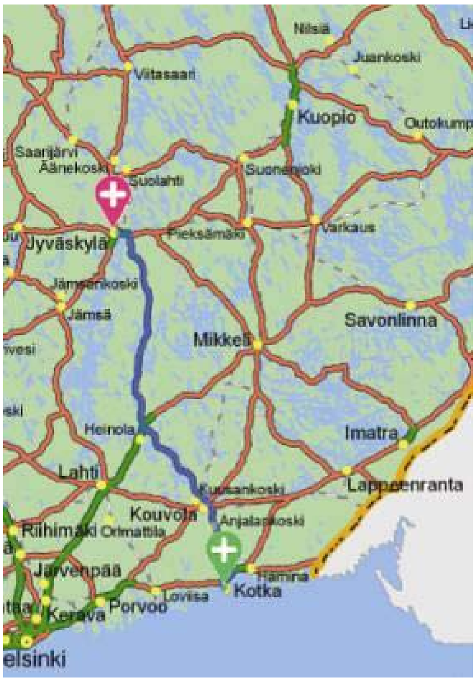

Figure 26. The Keitele Canal (Source: PLATINA)

Today the sector is still affected by this uncompleted canal, not only because of the increased demand for environmental friendly transport, and especially for the export of bio fuel produced in Finland, but also because of the cruise industry, only a few vessels of which can enter the canal, while only minor investments are needed.

The objectives of the project are:

- to complete the canal started in 1993,
- to establish terminals for bio fuel and other cargoes, and
- to construct vessels that allow year-round sailing.

10-12 terminals in the Keitele-Päijänne region are foreseen. The target area of each terminal is 10-15 hectares, with a quay length of minimum 200 meters. The preliminary plan is that the terminals will be subordinated to the Coastal and Inland Water Traffic Association, which will lease them out to local chip plants and bio-energy companies.

An essential part of the project is the construction of a new vessel in a domestic shipyard in order to provide all-year transportation. The vessel is privately financed through a newly established company named Biolaivat Ky.

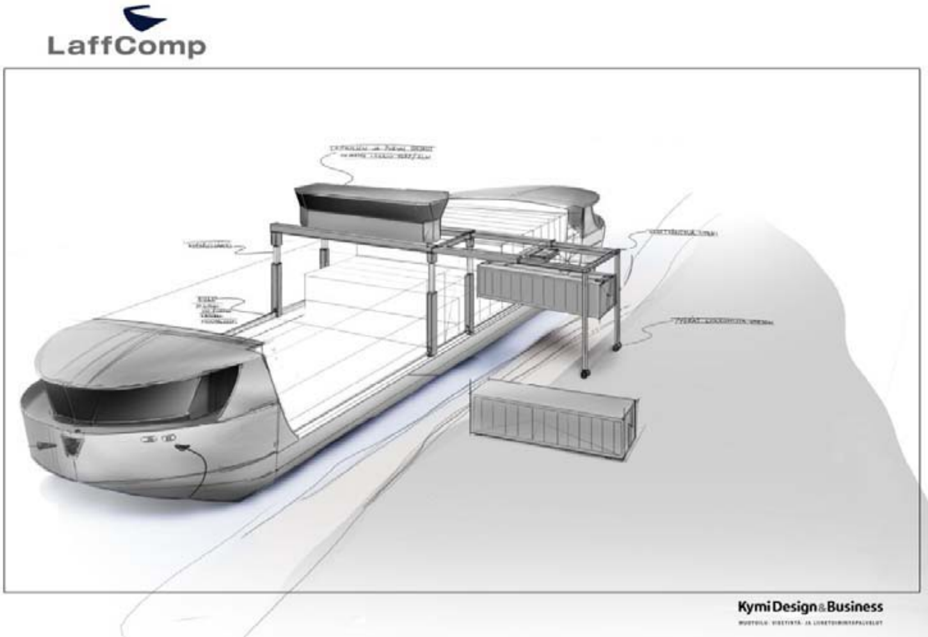

Figure 27. The vessel concept (Source: PLATINA)

The vessel will be ultra light to allow ice-going, it will be energy-efficient and use the environment friendly LNG as fuel. Some of its features are:

- Length: 110 m, width: 14 m, height: 10,4 m
- SOLAS 2002 17 F regulations to be used
- Draught min. 0.5 m, ship's own weight approx. 1000 ton
- Draught max. 2.4 m, total weight of vessel and cargo 3400 ton
- Maximum capacity approx. 2400 tons (dwt)
- 4 propulsion thrusters, 2 in each end.

The project is macro-economically feasible. The realization of the project supports the regional and local economy strongly. The long-term effects on business development, environment and the life standards of the local population are positive and their significance is expected to increase during the project's life. The first new vessel will be completed by 2015.

5.2.4 RoRo trial Rotterdam-Tiel-Zaandam-Hoorn

In April 2009, a trial was set up to test the technical and logistical feasibility of setting up a RoRo service line between Rotterdam-Tiel-Zaandam-Hoorn for the transportation of trailers, triggered by the developments related to the construction industry and the already congested roads in this area. In the province of North-Holland, the construction projects are expected to increase (building of new houses, infrastructure projects), resulting in an increasing flow of construction-related goods. Other parties with large freight flows between Rotterdam and Germany and between Rotterdam and North-Holland joined the trial to test whether the RoRo concept would fit into their internal logistics processes.

During the trial, a truck could deliver its trailer at one of the four selected handling points, where the trailer was transshipped and transported to the next handling point. The RoRo ship used was equipped with a flexible loading ramp, making it possible to bridge up to 3 meters in height and making the loading and unloading process as easy as possible. At the receiving handling point, another truck is ready to transport the freight to its final destination.

Although there is room for improvements, the trial results were positive. The next phase will be setting up a permanent service line between Tiel and Rotterdam.

The major advantages of the concept include:

- easy accessible service (there are no additional investments needed at the landside),
- most trailers are suitable for this concept,
- sustainable mode of transport,
- reduction of truck trips,
- emission reductions,
- noise reductions, and
- equal cost level compared to road transport.

Figure 28. A trailer is offloaded during the trial (Source: PLATINA)

The trial exhibits high transferability as there are no investments at the land-side (cranes or other equipment) needed for the use of RoRo ships. A RoRo ship with a flexible loading ramp makes the transferability possibilities even higher.

5.2.5 AMSbarge[15]

The Amsterdam region is densely populated and the roads are congested every day. Despite the fact that many factories are located alongside inland waterways, road transport is the dominating mode of transport. Congestion leads to unreliable delivery of goods and increased cost of transport from factory to short sea or deep sea port terminal. Truck companies used to use fixed door-to-door prices. New strategies involve time-based prices (cost per hour for the truck and crew).

The objective of the AMSbarge initiative was to establish a new type of logistics service including daily pick-up of containers from clients or terminals in areas where there is road congestion and transport of these to inland waterway-, short-sea- and deep-sea port terminals. These services are to be well integrated into intermodal door-to-door supply chains and their cost should not exceed the “normal” rate for road transport.

The service offered by AMSbarge is transport of containers from literally any point with access to water where a container may be placed, and to a convenient port terminal within the Amsterdam port and airport region.

Figure 29. The AMSbarge “Mercurius Amsterdam” empty (Source: PLATINA)

The unique capability of this service is that the barge can operate independently from land infrastructure. The barge carries its own container crane, which can lift 30 tons to a distance of 30 meters from the ship and can handle 18 containers per hour; the only requirement being that the ship can be moored along a quay for loading/unloading. The AMSbarge named ‘Mercurius Amsterdam’, is 86m long, 11.4m wide and can carry 144 TEUs (in 4 layers of containers).

[15] This case appears also in the PROMIT best practice reports.

The concept is especially attractive for shippers that have small assignments that do not allow for investing in quay-based handling equipment. The success in Amsterdam has led to the introduction of similar services in Rotterdam as well. A second crane barge was being built and was expected to start services in mid 2009.

Expansion of the system, however, towards more industrial areas proved to be difficult because spatial planning and environmental laws do not allow ships mooring in all relevant places or transshipment of cargo from trucks to ships.

The concept can easily be applied in cities/regions that have:

- a relatively dense waterway network,
- face congestion on roads, and
- have shippers located along water sites (including quays).

5.3 The BESTLOG project

5.3.1 General review of the project

The aim of the BestLog project was to create a dissemination and promotion platform for logistics best practice cases. 9 research institutes from 9 European countries partcipated in this project.

In its 9 Work Packages the project basically lays a theoretical foundation for transport logistics decision making, reviews existing standards in logistics education and certification, formulates a strategy for the establishment of a dissemination and promotion platform for best practice cases in logistics, collects and publishes a number of best practice cases, and describes the services offered by the platform.

The project looks into the general trends and constraints affecting transport logistics, including the problem of a steadily increasing growth in transport demand allied to GDP growth over the last decades. In this respect, an indicator named Transport Elasticity was introduced. Transport Elasticity is the relation between freight traffic growth and economic growth. A Transport Elasticity greater than 1 represents a higher traffic growth compared to economic growth (also known as “Coupling Problem”) and a Transport Elasticity less than 1 vice versa. The Transport Elasticity measured by total Freight Traffic growth (based on tonne km) and GDP growth (at constant prices) from 1994 until 2004 was analysed on a country level for all EU-25 countries.

It has also developed the **bestLog** model, combining following aspects of logistics decision-making in companies:

- The Supply Chain Management approach, as the cross-company logistics collaboration and integration with customers, suppliers and logistics service providers
- Long and short term planning horizons and the structures behind
- Collaboration with public institutes (like Public Private Partnership models) as strategic decisions
- Technologies as enablers of processes and strategies
- Processes as the operational implementation of strategies and the levers for measurement and execution
- Structures like products and location networks as long-term decision making.

The advantages of this model can be described as follows:

- Generic: Broad application (cross-sectors), less vulnerability on high-level
- Extensible for sector and industries
- Holistic approach and view considering Strategies, Processes and ICT.
- Incorporates different levels of decision making in companies (e.g. strategic operational or planning-execution).

The application and transferability of the model has been examined, as well as the development of a label/certificate, and the development of relevant training courses.

The project has also reviewed some key externalities such as noise, carbon emissions, congestion, and accidents. It has analyzed the logistics profiles of 31 European countries, which could be taken into account as a layer to our corridor definition.

The four best practice cases presented below is a selection among those appearing on the project's website.

5.3.2 Baxter: Healthcare goods by inland waterway

Reliability is the main concern for Baxter in its worldwide healthcare business. The reasons are the strict deadlines and high-level requirements of the healthcare sector. Uncertainties in transportation and delivery processes are not accepted, either by customers or by Baxter itself.

One of the long-time problems has been the uncertainty in delivery times from the large ports in Europe such as Rotterdam and Antwerp due to variations in the availability of services at the port and congestion on the roads outside the port area. The port in Antwerp is 111 km from Baxter's European distribution center at Lessines close to Brussels, Belgium, and Rotterdam is 215 km away. There is a high risk of congestion on the relevant roads, especially close to the ports and around Brussels.

This situation makes it very difficult for the company to ensure reliable deliveries from the deep sea part of the ports to the distribution center in the hinterland. The variations in delivery time can be anywhere between 8 hours and 3 whole days. At the same time, congestion on the roads and around the ports makes it difficult to deliver export goods to the ports in time for the departing ships in the company's distribution system for products leaving the European distribution center in Belgium and heading for distribution centers in other areas of Europe and the world.

In the search for more reliable transportation solutions in Europe, Baxter looked at inland navigation alternatives in the Netherlands and Belgium region, where high volumes of goods need to be transported to and from its European distribution center (EDC) in Lessines near Brussels. The inland navigation alternative turned out to be feasible once business relations with established with suitable service providers in the area.

Baxter uses inland navigation to transport many of its medical and biotechnical products within Europe rather than relying on the traditional method of road transportation. Baxter introduced the use of inland waterways from the deep sea areas of the ports in Antwerp and Rotterdam in the mid nineties and today (2009) organizes the shipment of more than 1,000 containers from the ports to the European distribution center each year.

The inland navigation solution includes barge transportation from the deep sea port areas where the barges are loaded to the Avelgem Container Terminal located 34 km from the EDC. The delivery times from Antwerp and Rotterdam are 18 and 14 hours, respectively, which allows 24-hour service (on average). The containers are transported from the Avelgem Container Terminal to the EDC by truck.

After the success of the solution with imports, Baxter is now also using the inland waterways distribution platform for the transport of its exports as well as transporting products from the distribution center to regional distribution centers in Europe and around the world. The containers used for imports are turned around and used for export, increasing the utilization degree of the containers and reducing the number of empty runs.

The solution has turned out to be a success in various ways. Costs are down 40% compared to previous solutions. At the same time, delivery reliability has increased as delivery variations have decreased, while barges consume only 20% of the fuel needed to transport each kilo of goods by truck. An average ship can carry as much as 120 trucks with a 40-foot container loading space, and this takes a high volume of truck traffic off the roads.

Lessons learned:

- Inland navigation has traditionally been used for the transportation of low-value goods such as bulk products or project cargo. The transportation of high-quality goods via inland waterways is, however, just as effective.
- The reliability of inland navigation is superior to that of road transportation and little or nothing is sacrificed in terms of flexibility despite the obvious limitation due to the dependence on infrastructure.
- Increased reliability was the main driver behind the solution, and the desire to minimize variations in delivery time. At the same time, the new inland navigation solution reduced total transportation costs by 40%, a welcome outcome but not one that was prioritized at the outset.

5.3.3 Cargo Domizil: Unit load rail shipments

Cargo Domizil was launched in 1981 as a division of SBB (the Swiss railways) to execute unit load rail shipments. As the aim of the Swiss government and of the state-owned SBB was to shift freight traffic from road to rail, SBB developed long-haul rail freight services with collection/distribution by truck. The business model initially failed due to organizational and operational inefficiencies, and the operation was unprofitable.

Meanwhile, private sector transportation companies in Switzerland were affected by a change in the government’s transport policy - specifically by a national ban on night-time trucking (10 pm-5 am) and by relatively high per-kilometer tolls for trucks on all Swiss roads.

After its partial privatization in 1992, SBB sold Cargo Domizil to a consortium of three large and medium-sized road haulage contractors. This consortium is called Transvision and comprises Camion Transport AG, Galliker Transport AG and, Planzer Transport AG. These co-owners needed to restructure Cargo Domizil’s operations to make its “combined mode” service competitive with road haulage services, capitalizing on the advantages of overnight rail movements and the negative image of road transport, especially in Switzerland.

Cargo Domizil introduced less-than-full-truckload (LTL) shipments via combined rail/road facilities. This system is seen as unique in Europe, where LTL shipments are generally moved solely by road. Daily 24-hour deliveries of unit loads to locations across Switzerland are guaranteed by the road/rail network. The three partner companies manage 11 Cargo Domizil logistics depots between them, and all depots are at rail trackside locations.

Cargo Domizil trucks collect consignments during the afternoon and take them to these rail-side depots, where they are loaded on trains, forwarded to Olten near Zurich, sorted by the SBB and sent to their destination depot overnight. Cargo Domizil normally uses around 250 rail cars per night. In the morning, trains arrive at the destination logistics depots, where the freight is transferred back to a truck and delivered to the customer in the morning.

Besides avoiding the night-time trucking ban and expensive road tolls, the use of rail offers significant advantages in Switzerland's mountainous regions, which are sometimes difficult to reach by truck. (Switzerland built tunnels exclusively for trains).

Thanks to the hub-and-spoke structure of Cargo Domizil's logistics depots, the company's drivers always operate in the same region and are familiar both with routes and individual customers – an advantage in providing courteous and friendly service, especially in Switzerland, which has three official languages and where customers expect to be addressed in their own mother tongue.

Lessons learned:

The success of the restructuring of a formerly state-owned company was underpinned by the collaboration-based relstionship between the consortium partners. Only their strong commitment could have ensured Cargo Domizil's continuing success. The partners are still working together without any detailed contractual arrangement, other than the articles of association of Cargo Domizil AG itself.

- The consortium realized early on that logistics customers preferred "green" transport to conventional road haulage, but only when offered at the same price, so it wanted to offer rail transport services for unit loads.
- The consortium wanted to gain a competitive advantage over other logistics providers by moving goods at night when competitors could not use their trucks.
- Switzerland's extensive rail network and the partners' local distribution operations enabled them to cover the whole of the country while reducing the number of own distribution depots.
- New operating structures were particularly important in enabling the success of the now privately-owned Cargo Domizil.
- Personnel training was particularly important, given the management and coordination challenges created by reducing the number of logistics depots.

Last but not least, the political environment in Switzerland had a major influence on the success of the concept of LTL rail shipments. The night-time trucking ban and high road tolls in combination with Switzerland's highly developed rail network contributed significantly to the project's success.

5.3.4 Daimler: “Adaptive logistics” project

In light of the changed legal framework resulting from the implementation of the German Transport Reform Act (TRG), the introduction of new technology for trailers (e.g. curtainsides) and new packaging materials, Daimler AG saw the need to examine and rethink the issue of load securement for material transports.

The main driver was compliance with the legal requirements relating to load securement measures in Germany (derived from the VDI 2700 standard as an acknowledged “rule of technology”). In this area, the legislator used the German Transport Reform Act (TRG) in 2000 to once again assign greater and more clearly defined responsibility for safe load securement to the loading companies as the clients who place the actual orders with the transport companies.

A further objective was to minimise in-plant process time for loading and unloading operations to ensure that the forecasted increase in transport volumes would not lead to higher throughout times.

Two systematic options for load securement on trucks presented themselves: friction-locking securement (tying down with lashing straps) or mechanically interlocking securement (load retention by the body of the vehicle).

The “Daimler Load Security 9.5” directive enables all process participants (material supplier, transport provider and Daimler AG) to secure loads solely by means of the design of the vehicle body and using standardised load carriers. For this purpose, the trailers must meet certain specifications in terms of stability and design. These specifications are as follows:

- Front wall: Reinforced front wall with a continuous width of at least 2,40 m
- Side wall: Pallet stop bar, pallet posts, load securing tarpaulins, blocking boards
- Roof: Lifting roof with reinforced roof design
- Rear portal: Minimum strength and minimum number of locking gears (twist locks)

If they meet these requirements, the trailers can be universally used by other industrial sectors and for other goods (e.g. paper, palletised goods etc.). The new load carriers possess dimensions based on the ISO standard and are stackable in mechanically interlocking mode with a footprint of at least 600 x 1000mm.

Daimler AG achieves several benefits based on this good practice. This more operational and technical solution enables Daimler AG to increase the stability and quality of supply operations. The benefits are of economic, environmental and social nature:

- Less complex load securement measures and processes resulted in optimised transport costs.
- The improvement of the process resulted in a reduction in overall process time and costs (for loading, safety, transport, unloading) compared to the use of a friction-locking load securement solution in line with the VDI 2700 standard.
- As a result, it is possible to absolutely minimise the need for separate transport insurance.
- Process improvement compared to friction-locking load securement in line with the VDI 2700 standard increased the eco-productivity of vehicles and reduced the use of load securement equipment (e.g. anti-slip matting, lashing straps etc.).
- Accidents involving trucks pose a risk to the health of people and, in the case of hazardous products, to the environment.

- With „Daimler Load Security 9.5“, Daimler AG underlines its social responsibility for driving, loading and unloading personnel as well as other road users. Responsible securement of the load is a social necessity in order to ensure the safety and protection of personnel who are directly or indirectly involved in the process.

Lessons learned:

- Shortcoming: Lack of load securement specifications for Daimler load carriers Solution: Creation of a Group-wide working group with independent expert support, definition of a budget
- Shortcoming: Use of pallets and load carriers that are unsuitable for mechanical friction-locking load securement (tying down) Solution: Mechanically interlocking load securement through stabilisation of the vehicle body
- Shortcoming: Lack of load securement specifications for curtain side and MEGA trailers with no side wall for loads. Solution: Road tests and stipulation of body design – e.g. pallet stop bar and roof reinforcement
- Shortcoming: Lack of legal predictability for the organisation and particularly for management personnel (shipper responsibility) Solution: Compilation of a guideline with Group-wide validity.

With its example, Daimler AG shows how an “adaptive logistics” strategy identifies the efficiency potential of a socially driven legal regulation and succeeds in implementing this regulation in the form of high-quality and stable processes.

5.3.5 FM Logistics: Pooling the retail FMCG sector

The beginning of 2005 was important for the Polish market due to several changes that were observed in the FMCG sector. Sales volume increased, which resulted in a higher frequency of retailer orders placed with producers, who wanted to ensure that each order was fulfilled in line with the retailers’ requirements.

This situation influenced the operations of the logistics service provider, as it was necessary to handle more orders in the same amount of time. Transportation costs were soaring due to LTL (less than truckload) transports which were not cost-effective. Moreover, fuel prices were also rising, and both traffic jams and congestion made the distribution process in FMCG sector more complex.

In the Polish market, it also became apparent that due to the high share of conventional trade in the distribution channels, logistics processes were not efficient enough and the cost of performing these processes was growing rapidly.

The pooling concept, commonly known as sharing, aims to group assets and equipment in order to maximise advantages for the users. In simple terms, it means sharing transportation, warehousing and distribution. Pooling helps to regroup flows of goods coming from the food industry and heading for the same points of delivery, and thus to reduce operational costs. Instead of concentrating on owning assets, pooling encourages the company to adapt its solutions to new market conditions, extremely fierce competition and the economic downturn.

Based on FM's experiences in France, the Polish subsidiary implemented the idea pooling, but the pooling concept was geared towards the specific market characteristics. In France, where the pooling concept originated, FM Logistic and Carrefour have decided to cooperate with FMCG suppliers in order to optimise the logistics processes on the one hand and gain a greater competitive edge on the other. They searched for innovative logistics operations which would be suitable for the FMCG sector in France.

Pooling began in 2004, when it was implemented in France by FM, Carrefour and three FMCG producers - Benedicta, Nutrimaine and Pastacorn. In 2005 three more producers joined the system and in mid-2007 six regional forwarders were also “signed up”. The system was tailored to the needs of all partners.

In the Polish market, different FMCG producers are involved and the practice itself has different characteristics. Pooling is extended to other retailers besides Carrefour – and FM Logistic has defined several points of delivery which are the same for all the participating producers.

FM Logistic Poland adapted the French solution to the requirements of the Polish market, where conventional trade has a high market share in the FMCG sector. This meant that a high number of distributors had to be involved in order to ensure the profitability of the model. Moreover, in order to cover the whole market, the products of the FMCG producers had to be available at numerous points of delivery.

FM Logistic links orders from producers and performs one delivery to one retailer's premises comprising all the ordered products from the various producers. Thanks to this system, FM sends FTLs to retailers and offers higher delivery frequency, something that is very important in the FMCG sector.

The practice has a substantial impact on service quality, resource utilisation and the response capability of FM Logistic and its clients. The quality of services offered by FM has improved and its portfolio has been widened, making FM more competitive. Almost all deliveries are made on time, and the time required for unloading of goods has also been reduced. As for capacity utilisation, pooling has improved filling rates for road transports and almost eliminated LTL deliveries. Moreover, pooling allows all the players to ensure that all consumers can enjoy fresh products, as the frequency of deliveries is higher. In France alone, delivery frequency has increased by 34%.

The pooling practice has had a considerable influence on CO2 emissions (which are down by a massive 51% in France). In view of the fact that 28% of all waste gas emissions in the market come from transport operations, pooling represents a simple solution to the problem. Furthermore, fuel consumption has been reduced by 50%. The practice also positively impacts waste and recycling, as it reduces the quantity of obsolete goods in warehouses or in retailers' DC.

During the implementation of the pooling practice, it was observed that the health and safety of the local communities were improved, but no exact measurements were performed. Nevertheless, there are fewer trucks on the roads, leading to lower congestion levels and reduced emission of various hazardous chemicals. One very important benefit of the pooling practice is the way it improves employee skills in the fields of operational planning, negotiating and training.

Lessons learned:

- The need for cooperation, trust and information sharing between partners. The practice of pooling is based on information sharing, especially in the case of ordering and distribution requirements. All producers should pass on orders from their clients according to a scheme prepared by FM Logistic. Moreover, including FM in promotion planning turns out to be essential in order to ensure the continuous flow of the right products within the right time frame.
- The internal processes of FMCG producers are an indispensable part of the overall process. This applies to both the logistics and the sales departments, who perceive pooling in different ways. The sales department does not concentrate on reducing costs but on increasing sales volume and value. For FM Logistic, it was important to show the sales department that pooling does not adversely affect sales.
- Pooling is a life-long learning and change process. Rapid and frequent changes in market conditions and structures mean that once the practice has been implemented, continuous monitoring is also essential. Delivery points can differ in time (depending on the existence of the proper infrastructure) or delivery volumes may increase.

5.4 The BE Logic project

The project has been presented in detail in Section 4.1 Here, reference is made to the “best practice” part of it. The term “good practice” is used in the BE Logic documents in place of the usual term “best practice”, as the later one is considered far too ambitious. A “good practice” case is neither god-given nor an undisputable case that can be transferred to any other chain. A logistic chain is given this label when it is superior to other competing logistic solutions and when it can trigger positive influences in terms of learning effects.

The criteria for selecting the “good practice” cases were:

- achieving a modal shift from road to intermodal transport using rail, inland navigation or short sea shipping
- cost reduction through new technologies or improved processes
- service improvements offering potential to attract additional cargo, and
- reduction of emissions.

Twelve “good practice” cases are presented in Deliverable D3.2 aiming to support the identification of KPIs and the development of benchmarking methodologies through a bottom-up approach. The following three cases are most insightful:

Container shuttle by barge between Bremerhaven and Bremen: The shuttle connects 2 sea terminals in Bremerhaven with – in most times – shippers and consignees in Bremen directly (4 terminals and 5 piers). In these cases no pre- and end-haulage is needed. If pre- or end-haulage is necessary, it is done in most cases by barge. The system was established in 2000 by ACOS Group. The shuttle replaces unimodal road transport and is in competition with truck transport concerning price and time.

NTT 2000 and NeCoSS hinterland transport of containers by train: Shipping companies offer departures of their container ships from the ports of Bremerhaven and Hamburg for advertising reasons, but in reality the ships call at only one of the two ports. So, the containers delivered from the consignors or received by the consignees in the port, which is not called at by the ship, are to be exchanged between the ports. This was done originally by trucks, which however were not using the motorways between the ports but country roads because of the shorter distance. This led to high congestion of the road network and problems for the people living along these roads. To address this problem, the forwarding company ACOS and the private railway company EVB created in 2000 a rail container shuttle linking the ports of Bremerhaven and Hamburg including the "Roland Umschlag" intermodal terminal in Bremen. This shuttle is called "Neutral Triangle Train" (NTT 2000). The NTT 2000 trains formally have schedules, but they are operated very flexible.

In 2002, the partners ACOS and EVB established in co-operation with Connex Cargo (now Veolia Cargo) hinterland rail container connections that are not served by the major railway intermodal operators because there is not enough freight potential for block trains. This service is called "Neutral Container Shuttle System" (NeCoSS). The NeCoSS block trains start in Bremen Roland and run to nodal stations where the block trains are departed into two or three wagon groups, which are brought to their final destinations by regional railway companies and vice versa. This system makes it possible to serve intermodal terminals that have not enough potential for block trains in hinterland container transport. NTT 2000 and NeCoSS are linked in the Bremen Roland terminal, where containers are exchanged between these train systems.

Green Label: The Green Label project was initiated in July 2008 by the Dutch governmental agency Connekt (project Duurzame Logistiek). BCTN, a company operating 4 inland navigation terminals (Den Bosch, Hengelo, Nijmegen and Wanssum), was among the first ones to receive the Green Label award. This is an individual commitment for 2 years with the aim of reducing energy consumption. The Green Label is being awarded to companies on the basis of periodic measurable improvements on key performance indicators. One of the important conditions is that targets and results are published. The KPIs are CO_2 reduction, gasoline consumption and capacity utilization. The Green Label scheme is still under development. A tier system (label A, B or C) is being considered in order to achieve continuous improvement.

5.5 The Swedish Green Corridors

The Swedish ”Green Corridors” initiative focuses on transport routes and collaboration among shippers, forwarders, industry and haulers in order to optimise the use of transport capacity which makes a better utilisation of the transport resources.

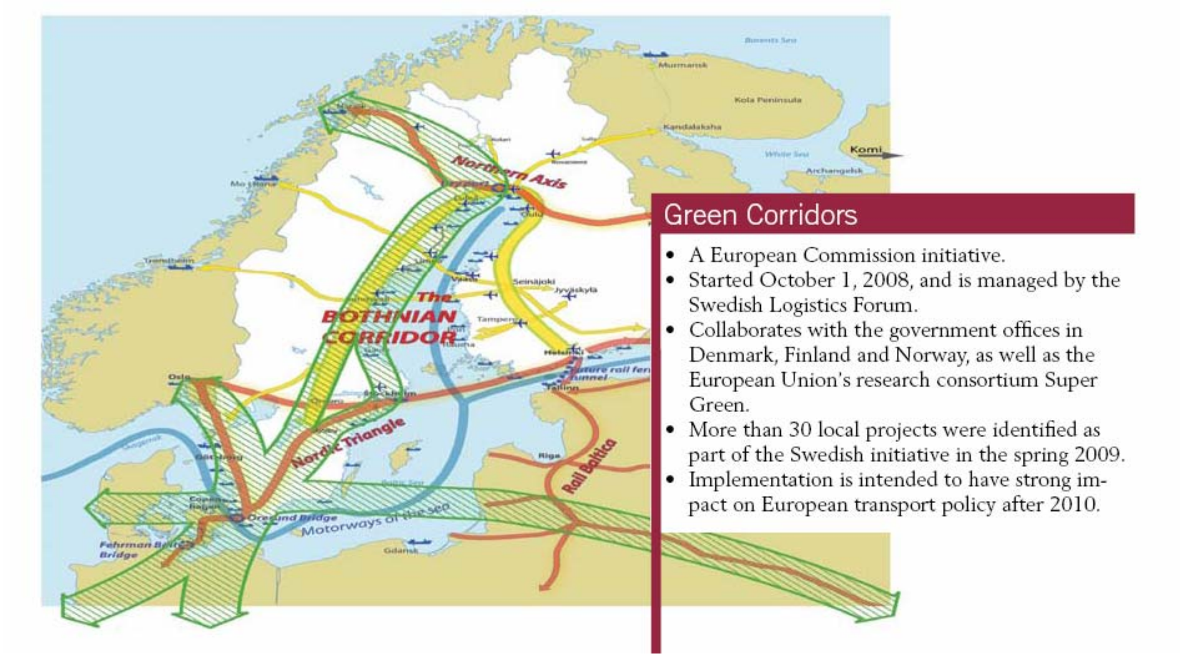

Figure 30. The Swedish "Green corridors" initiative

This will reduce the impact on the environment and make better use of the capacities. The approach concerns all transport modes and may lead to shifts from one mode of transport to another. The project is managed by the Swedish Logistics forum. The project started in year 2008 and collaborates today with the governments of Denmark, Finland and Norway, as well as the authorities that provide the infrastructure.

The general objectives are more effective and sustainable freight transport and logistics services. There have been business cases like Stora Enso's rail/ferry system Sweden-Belgium with dedicated containers and Hector Rail/VanDierens intermodal direct train Germany-Denmark-Sweden (without change of locomotives), but also demonstrations like Scania/Volvo/GreenCargo/KappAhls project "climate neutral intermodal transport of clothes" with ethanol powered trucks in Stockholm and DME-powered trucks in Gothenburg and water generated electric intermodal train in between.

Another demonstrator is a 32 meter container truck combined with an intermodal train Vaggeryd-Gothenburg, yet another is an intermodal solution for sensible freight (cooling) Germany-Skåne. There are also some proposed demos of ITS-solutions for road freight, longer trains on the Hallsberg-Maschen corridor and longer vehicles in timber transport. There is currently also a larger project on the table with Volvo as lead partner, for an intermodal chain Gothenburg-Malmö with ITS-components, innovative vehicles and infrastructure, etc.

In addition, there are three international transport projects in the Baltic region, exhibiting important "greening" characteristics:

The **"East-West Transport Corridor" (EWTC)** project[16] was a cooperative venture between 42 different partners - local, regional and national authorities, universities, harbours and private stakeholders - in Denmark, Lithuania, Russia and Sweden. The project started in 2006 with Region Blekinge as the Lead Partner. A project secretariat was established in Karlshamn, Sweden. It was co-financed by the project partners and the Interreg IIIB Baltic Sea 2000-2006 programme. EWTC aimed to strengthen the transport development through infrastructure improvements, new solutions for business, logistics and co-operation between researchers.

The success of EWTC led to a follow up project named EWTC II. It started in September 2009 and will run for 3 years with a total budget of about 6 MEUR. Around 70 partners from Sweden, Lithuania, Germany, Russia, Italy, China and Denmark have joined the project. Several of the partners come from the private sector. Moreover, the project is supported by both the Swedish and Lithuanian governments.

EWTC II will highlight the development of a "Green Corridor Concept" as a best practise case in the European context. Its objectives are:

- To make EWTC a good example of a Green Transport Corridor in line with the EU's latest transport policies also meeting market demands for more efficient and environmental friendly transports.
- To develop an innovative pilot testing ground where modern technology and information systems contribute to increased efficiency, traffic safety and security as well as reduced environment impact along the corridor.
- To support economic growth within the corridor particularly in ports and inland hubs by stimulating new business models for e.g. railway transport.

The **SCANDRIA** project[17] is a cooperation of 19 partners from Germany, Denmark, Sweden, Finland and Norway willing to assume a future role in developing a green and innovative transport corridor that connects capitals and metropolitan regions along the shortest way from Scandinavia to the Adriatic Sea. It is partly financed by the Baltic Sea Region Programme of the European Union. Scandria fosters co-modality, rail transport and environmentally friendly solutions in road transport. Scandria will further improve logistic services and activate the corridors' growth potentials. Its specific objectives are:

- to increase the capacity of transport infrastructures as a necessary precondition for an efficient settlement of transport flows,
- to develop and disseminate innovative logistics solutions, a goal which is in line with the EU Freight Transport Logistics Action Plan, and
- to agree on a common strategic framework as basis for political, administrative, economic and scientific action for the future corridor development.

The **TransBaltic** project[18] is a strategic project co-financed by the EU Baltic Sea Programme 2007-2013. The overall objective of TransBaltic is to provide regional level incentives for the

[16] http://www.eastwesttc.org/about-ewtc.aspx

[17] http://www.scandriaproject.eu/

[18] http://transbaltic.eu/about/

creation of a comprehensive multimodal transport system in the Baltic Sea Region (BSR). This is to be achieved by means of joint transport development measures and jointly implemented business concepts. The expected outcomes of the project are:

- Action plan with infrastructure, logistics and transport capacity measures addressing pan-Baltic connectivity, interoperability and intermodality problems from the sustainable regional development perspective.
- Guidelines on BSR-specific transport intermodality and interoperability solutions (BSR transport blueprints) – which would test and verify EU transport and cohesion policy proposals.
- Traffic forecasts and scenarios for particular TEN-T and secondary transport corridors in the Baltic Sea Region – as a decision support basis for regional and national transport investments.
- Manual and handbook on empty freight reduction – to decrease space requirements and road/rail haulage cost in container traffic.
- Feasibility studies and implementation plans for dry ports and for port-bound road traffic telematics.
- Pre-feasibility and impact assessment studies for rail transport in selected parts of the Region.
- Business plans for, inter alia, the empty container management and for the ICT toolbox (a web-based tool to help business users, especially SMEs, plan optimum intermodal door-to-door solutions for the transport of cargo).
- Training methodology for a competence management system in harbour logistics.
- A meeting place for public and private transport stakeholders to discuss specific harmonisation needs from the regional growth perspective (incl. e.g. challenges for Baltic ports, human capacity building in transport operations and implementation of a green corridor concept in the Baltic Sea Region).

6 KPI experiences from other sectors of the society

In this section, experiences of KPIs in other sectors of the society are investigated and analysed, so as to assess their relevance in monitoring green corridors. The study focuses on three major international organisations: the World Resources Institute, the World Business Council for Sustainable Development and the European Environment Agency.

6.1 World Resources Institute

The World Resources Institute (WRI) is a global entity that seeks for knowledge and research to capture practical ways and visionary policies for improving quality of living and the environment. Its goal is to promote solutions for a sustainable well-being of human on Earth. Its work is organized into four areas:

- Climate Protection; focusing on the reduction of emitting polluters and green house gases (GHG).
- Governance; promoting ideas on environment and social equities to people and institutions.
- Markets & Enterprise; promoting sustainability and environmental friendly ideas to markets and enterprises.
- People & Ecosystems; focusing on the sustainable human behaviour towards nature and natural sources.

Shedding a strong focus on results, the WRI generates annual objective reviews; where one can find out its efforts on the aforementioned work areas. An example of these releases can be found (in map format) in the address http://www.wri.org/about/results. Some of the most relevant to SuperGreen WRI projects are presented below. Each project is shortly described and discussed, so that the experience of WRI in the KPI areas is adequately reflected.

6.1.1 Climate Analysis Indicators Tool (CAIT)[19]

The Climate Analysis Indicators Tool (CAIT) is a WRI project that reflects significant experience relevant to the environment and climate change issues. It belongs to the Climate, Energy & Transport sector of WRI's focus areas. The CAIT is a database of greenhouse gas inventories and climate-relevant, socio-economic and natural resource indicators, compiled from internationally recognised agencies. Its objective is to provide accurate data as an essential component of decision making and policy development.

In this project, KPIs relevant to the 'Environment' KPI area of SuperGreen can be identified. The project itself serves as a database of spatially categorised data for emissions, polluters, etc. This resembles a lot to the KPI of polluters and CO_2 emissions per corridor, as defined in the SuperGreen project. It is important to note that data are spatially categorized, i.e. emission values for specific areas are defined. Thus, CAIT could probably serve as a validation resource during SuperGreen's corridor benchmarking phase.

[19] Homepage: http://cait.wri.org/

Relevant publications can be found in: http://www.wri.org/publications/3082.

6.1.2 Deploying Climate-Friendly Technologies: A Wedges Approach to Clean Investment[20]

Within this project, WRI examines:

- what is the market potential and which are the political and financial barriers for adopting several clean technologies (i.e. biofuels from cellulose, grain, or vegetable oils, carbon capture and geologic storage, efficiency in transportation and power generation, wind energy, fuel-switching from coal to natural gas);
- how government policies and economies affect their deployment;
- how long is the time to deliver these technologies to the market and what is the level of competitiveness between different companies on this direction.

The goal of this project is to deliver supportive work to accelerate the government policy, corporate action, and financial investment decisions. The project draws on expertise from other WRI projects, such as the CCS project, EMBARQ, the Green Power Market Development Group, and the Biofuels project.

[20] Homepage: http://www.wri.org/project/climate-wedges

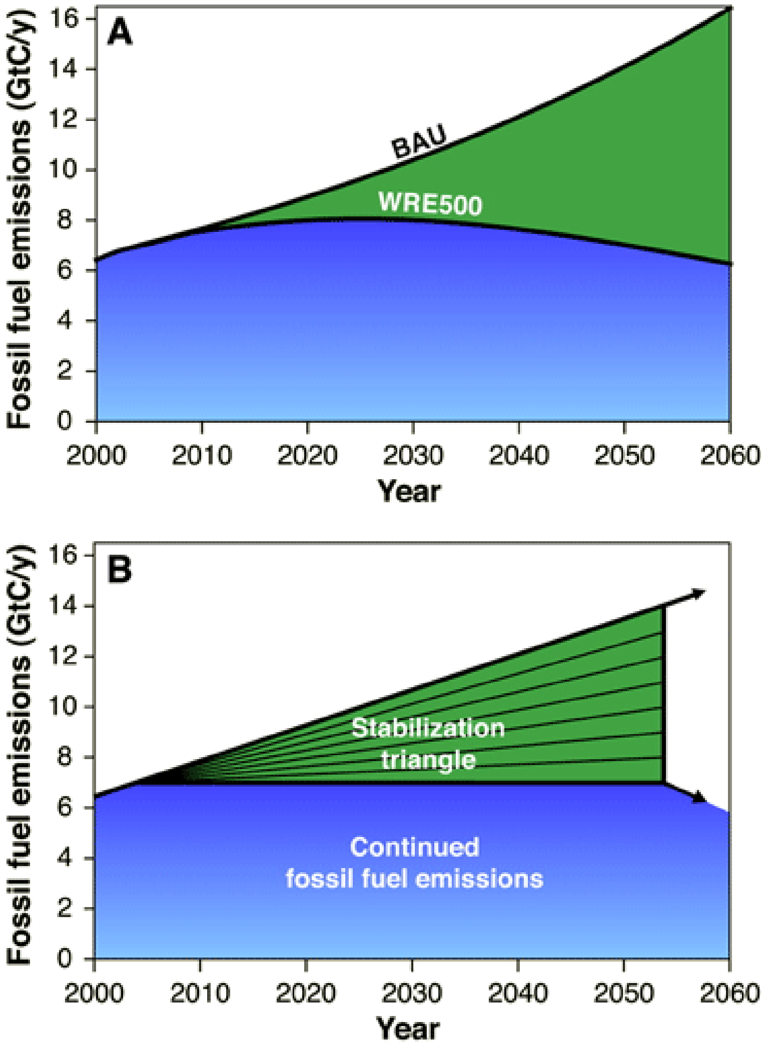

Figure 31. Fossil fuel emissions, manageable wedges (Source: WRI)

Since the main focus areas of this project are: i) promotion of clean technologies to reduce polluters, and ii) investigation on the financial capabilities, benefits, deficits, and bottlenecks of deploying clean technologies, its material and findings are highly related to the KPI areas of Efficiency and the Environment and relevant KPIs can be retrieved. To illustrate this, a set of diagrams, retrieved from the homepage of the project, is shown in Figure 31. They present the fossil fuel emissions in GtC/y gigatonne of carbon emissions per year and break them into manageable wedges. It seems that seven wedges are needed to stabilize global emissions at current levels by 2050.

Relevant publications can be found in: http://www.wri.org/publications/4142.

6.1.3 EarthTrends: Environmental Information[21]

This project is related to the KPI areas of Efficiency, Environment and Social issues. It includes indicators for a large variety of environmental, social and economical data, gathered around the world. As an example, a searchable database is accommodated in Earthtrends including figures on GDP, debt, imports/exports in goods and services in US$ per year or as a percentage of GDP, foreign direct investments, net flows, national savings, poverty rates, and many other indicators per country and year.

The reader is encouraged to further investigate Earthtrends utilities, following the aforementioned link on the network.

EarthTrends provides an on-line collection of data and analysis about the environmental, social, and economic trends and offers statistics, maps, and graphics for more than 200 countries. It gathers data from more than 40 of the world’s leading statistical agencies, along with WRI-generated maps and analyses, into a single repository.

Relevant publications can be found in: http://www.wri.org/publications/2445.

6.1.4 EMBARQ: The WRI Center for Sustainable Transport[22]

This project is related to the KPI areas of Social issues, Service quality and Infrastructure.

The EMBARQ global network investigates environmentally and financially sustainable transport solutions to improve the quality of life in cities. It includes five Centers for Sustainable Transport, located in Mexico, Brazil, India, Turkey and the Andean Region, that work together with local transport authorities to reduce pollution, improve public health, and create safe, accessible and attractive urban public spaces. Expertise fields range from architecture to air quality management, geography to journalism, and sociology to civil and transport engineering. Its objective is to increase the quality of life in cities by focusing on the improvement of transport (related to congestion, polluters). Fuel use reduction, air pollution minimisation, quality and cost effectiveness of urban transport, improvement of accessibility, traffic safety and public security, and many others are in the focus of this project.

Relevant publications can be found in: http://www.wri.org/publications/3858.

6.1.5 ENVEST: Environmental Intelligence for Tomorrow's Markets[23]

The ENVEST project belongs to the Climate, Energy & Transport WRI work area and contains indicators and data related to the KPI areas of Efficiency and the Environment.

WRI believes that discounting the environmental implications on risk and return will facilitate markets to allocate capital to companies that follow environmental policies. In this context, WRI collaborates with the investors to evaluate financial implications of environmental risks and opportunities and support their decision, by supplying important knowledge and information.

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[21] Homepage: http://earthtrends.wri.org/

[22] Homepage: http://www.embarq.org/

[23] Homepage: http://www.wri.org/project/envest

Relevant publications can be found in: http://www.wri.org/publications/2944.

6.2 World Business Council for Sustainable Development

The World Business Council for Sustainable Development (WBCSD) is a global association consisting of 200 companies from around world scoping to support business operation and development towards a sustainable future. To achieve this scope, companies exchange knowledge and best practices, results and new ideas are discussed (during forums, etc), and published to advise towards sustainable business solutions.

The Council's work is organized in four 'focus areas':

- Energy and Climate
- Development
- The Business Role
- Ecosystems

To achieve its objectives, the Council holds forums, publications, initiatives and projects in all focus areas. The on-going projects are: Energy Efficiency in Buildings, Water, Cement, Electricity Utilities, Forest Products, Mining & Minerals, Mobility, and Tire Industry. Initiatives are set up in Eco-Patent Commons and Urban Infrastructure.

Among the aforementioned, several programs and initiatives are related to the KPI areas studied in the SuperGreen project. In the following table, a brief presentation and discussion on a selected part of WBCSD's work reflect the latter's experience on Economy/Efficiency, Environment, Service/Quality, Infrastructure and Social issues.

6.2.1 Life Cycle Initiative[24]

At the Business Role focus area, the WBCSD aims to explore and indentify the role of business on several sustainability issues, influence stakeholders to understand this role, contribute to the sustainable development and implement sustainable solutions. To reach these targets, research and case studies with companies are held, their results being published in journals and newsletters. An important initiative related to this area it the Life Cycle Initiative.

The WBCSD participates in the International Life Cycle Partnership, known as the Life Cycle Initiative, together with the United Nations Environment Programme (UNEP) and the Society for Environmental Toxicology and Chemistry (SETAC). The scope of the Life Cycle Initiative on the sustainable Value Chain is to promote, assist and support life cycle thinking and life cycle approaches –including life cycle management– among WBCSD member companies and their suppliers, customers and value chain partners for the sustainable innovation and global trade of more sustainable products. This should result in:

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[24] Homepage: http://lcinitiative.unep.fr/default.asp?site=lcinit

http://www.wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=MTEzOA&doOpen=1&ClickMenu=LeftMenu ,

http://www.wbcsd.org/DocRoot/inRjcUqcjX3UepuL9xAN/MeasuringEE.pdf

- increased business value
- more cost savings
- increased competitiveness and market shares
- better public image and reputation
- improved brand value
- greater market access

The initiative is preparing an Issue Brief on how companies integrate Life Cycle Thinking in their business practices.

The added value of the Initiative includes:

- The ability to access and mobilise an established and growing global network of over 2000 interested members who have been and continue to be interested in understanding and advancing Life Cycle approaches worldwide. These experts represent industry, Government, academics and the service sectors and are the leaders in developing and applying Life Cycle Assessment (LCA) and Life Cycle Management (LCM) worldwide.
- The ability to gather and manage examples of best practices and Life Cycle achievements across the world.
- The opportunity to connect science and decision making in policy and business with the supply and demand side of Life Cycle approaches. Therefore, and opportunity exists to become the global authority for consensus building and peer review on methodological questions and environmental assessments of natural resources, materials and products in the field of science.

In this context, the WBCSD, promotes eco-efficiency and the concept of creating more goods and services while using fewer resources and creating less waste and pollution. Eco-efficiency can be achieved through the delivery of "competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing environmental impacts of goods and resource intensity throughout the entire life-cycle to a level at least in line with the Earth's estimated carrying capacity." Two WBCSD publications, Eco-efficiency - Creating more value with less impact (500 kb) and Measuring eco-efficiency – a guide to reporting company performance (500 kb) have notably influenced thinking over the recent years.

The latter is published together with the Monsanto Company and the Environmental Resources Management plc, and addresses financial value indicators, eco-efficiency ratios and other Economy/Efficiency/Environmental indicators.

Publications can be found in:

http://www.wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=MTE0NQ&doOpen=1&ClickMenu=LeftMenu

6.2.2 Sustainable Mobility[25]

The Sustainable Mobility project of WBCSD scopes to address the challenges and the potentials of worldwide transport to contribute in economic growth, environmental improvement and social progress simultaneously. Unsustainable mobility means that the growing worldwide demand for transportation could not be met by simply expanding today's means of transportation. Unless different policies and decisions are taken, the current trends of mobility lead to an unsustainable transport future. In this context, the Sustainable Mobility project focuses on issues that concern highly the stakeholders of this sector, such as:

- congestion,
- inadequate infrastructure,
- land use,
- noise and pollution,
- reliance on non-renewable resources.

The main objective of the project is to consider how global mobility patterns could evolve in the period to 2030 and beyond, what policies could influence their evolution to a more sustainable transport, and what is required to deploy these policies. The main concern was laid on road transportation. The project was started in 2000 and concluded in 2004, by releasing the report: 'Mobility 2030: Meeting the Challenges to Sustainability'. From 2000 to 2004, dialogue and discussion with many stakeholders was carried out, all of them coordinated by Sustainable Mobility. The initial outcome of this work (2001) assessed the current worldwide situation and identified particular challenges to achieve sustainability, focusing on road transportation. One of the final conclusions of the Mobility 2030 report is that, as is, the worldwide mobility of people and goods is not sustainable. Seven goals for sustainable mobility are shaped in this report:

- Reduce conventional emissions from transport so that they do not constitute a significant public health concern anywhere in the world.
- Limit greenhouse gas (GHG) emissions from transport to sustainable levels.
- Reduce significantly the number of transport-related deaths and injuries worldwide.
- Reduce transport-related noise.
- Mitigate traffic congestion.
- Narrow "mobility divides" that exist within all countries and between the richest and poorest countries.
- Improve mobility opportunities for the general population in developed and developing societies.

All goals of this project are highly related to almost all KPI areas: Social issues, Service quality, Environment, and Infrastructure.

As defined in the 'Mobility 2030: Meeting the Challenges to Sustainability' report, the following 12 indicators for sustainable mobility are set:

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[25] Homepage: http://www.wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=ODE&doOpen=1&ClickMenu=LeftMenu

Accessibility – personal mobility: This indicator combines the percentage of households having access to motorized personal vehicles plus the percentage of households located within a certain distance of public transport of a given minimum quality, and reflects how convenient the means for mobility are for an individual.

Accessibility – goods mobility: This indicator focuses on the mobility of goods and reflects the delay between a request for and the receipt of service, as well as the distance that the shipper or customer receiving the shipment must transport the shipment themselves. As stated in the aforementioned report, the formulation for accessibility to goods mobility is 'a combination of response time (time to pick up shipment after requesting service, or time to deliver shipment after arrival) and the distance that a shipper or customer must travel to drop off or receive the shipment'.

Financial outlay to obtain desired personal and goods transport: This indicator reflects the private costs to afford of transport services, taking into account the existence of external costs, such road charges, extra fuel costs because of congestion, etc. For personal mobility, this indicator equals to: the share of individual (or family) budget devoted to personal travel. For goods mobility, it equals: the sum of logistics costs per unit (weight or value) moved per unit of distance.

Travel time: This indicator takes into account both average travel time on an origin-to-destination basis and the impact of congestion. Travel time for personal mobility is calculated using the formula: Average time required from origin to destination, including all switches of vehicle/mode and all "waiting" time. Travel time for goods mobility equals: Average origin to destination time required for shipment.

Reliability: This is a congestion indicator that reflects the degree of certainty in travel times on transportation systems and it is highly related to cargo security. Reliability in personal mobility equals to: Variability in door-to-door travel time for a "typical" mobility system user. Reliability in goods mobility is calculated as: Variability in origin-to-destination time for "typical" shipments of different types.

Safety: This indicator considers the likelihood that a person or goods are involved in incident(s) that might result in death/serious injuries or damages during a transfer. It also takes into account the perspective of the society as a whole, i.e. the total number of traffic-related deaths and serious injuries and the impact of goods' loss and damage due to road crashes to the economy. The formula to calculate the safety for personal mobility is: The probability that an individual will be killed or injured in an accident while using mobility system, and the total number of deaths and serious injuries (expressed as DALY – disability-adjusted life years) per year by category (air transport, automobile, truck, bus, moped, bicycle, pedestrian etc.). The formula to calculate the safety for goods mobility is: The probability that a given shipment will be damaged or destroyed and the total value of goods damaged or destroyed in a crash.

Security: This KPI considers: (i) the risk that violence can disrupt a personal or goods transportation system, possibly killing thousands and causing damage with costly effects, and (ii) the existence of threats for bodily harm when using personal transport systems and stealing when a shipment is transferred. For personal mobility, this KPI is calculated by: from the viewpoint of individuals, the probability that one will be harassed, robbed, or physically assaulted during a journey and from the viewpoint of society, in addition to the previous, the total number of incidents. For goods mobility, it is calculated by: the probability that a shipment will be stolen or damaged through pilferage. To account for the impact on the society, in addition to the previous formula, the total value of goods lost to theft and/or pilferage are also considered.

Impact on public revenues and expenditures: This indicator has a strong financial and business perspective. It is intended to cover government activities (public funds, policies) on generating a surplus of revenue over cost. It is measured as: the level and change in level of public capital and operating expenditures for providing transportation services and transportation infrastructure

Greenhouse Gases emissions: The formulation of this indicator is straightforward: GHG emissions per time period measured in carbon-equivalent units.

Impact on the environment and on public well-being: This indicator considers society's concern about mobility and its impact on the environment and on public well being. It takes into account: (i) Transport-related emissions, like NOx, CO, particulates, unburned hydrocarbons and lead per time period, (ii) Impact on eco-systems, e.g. habitats, water, land-use, (iii) Transport-related noise, calculated as the number of individuals (or percent of population) exposed to transport-related noise levels.

Resource use: This indicator reflects transport-related use of energy (fuels), energy security, land and materials. Its formula takes into account the following figures: (i) total transport-related use of particular fuels, (ii) the percentage of a region's energy supply coming from outside the region, (iii) the amount (or share) of land devoted to transportation activities, and (iv) the total volume of material use by transport sector; transport sector's share of total use; actual recycling rates.

Equity implications: The equity indicator reflects the distribution of sustainable mobility "values" across different population groups. For example, it includes access to means of mobility, cost of obtaining personal and goods mobility, and exposure to the effects of emissions and noise, threats to safety and security.

Prospective rate of return to private business: This indicator can be viewed as a threshold indicator of sustainability, showing the least normal rate for return, for which an activity can be regarded as efficient. The indicator equals to: the prospective return on investment available to an efficient private supplier of mobility-related goods and services, including capital and operating costs, private revenues, government-provided revenues and costs imposed by government regulatory policies.

Publications can be found in:

http://www.wbcsd.org/templates/TemplateWBCSD2/layout.asp?type=p&MenuId=MjYz&doOpen=1&ClickMenu=LeftMenu

6.2.3 Investment Funds

At this focus area, the WBCSD works together with policy-makers to address efficient and effective ideas that could shape a post-2012 international climate treaty, able to work with (inter-)national policies and measures. At this context, business experience and knowledge in addressing climate change are gained and built. Tools and information are provided to key stakeholders to support their own climate actions.

In this context, the WBCSD was recommended to shape processes to select private sector observers for the following funds that promote climate friendly actions and sustainable development:

- Climate Investment Funds (CIF) are designed to support low-carbon and climate-resilient development through scaled-up financing channelled through the African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank and World Bank Group.
- CIF includes the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF), which has three programs: the Pilot Program for Climate Resilience (PPCR), the Forest Investment Program (FIP) and Scaling up renewable energy program in low-income countries (SREP).

Criteria shed on these actions are related to the following KPI areas: Efficiency, Environment and Infrastructure.

6.3 The European Environment Agency

The European Environment Agency is the leading public body in Europe dedicated to providing timely, targeted, relevant and reliable information to policy-making agents and the public, to support sustainable development and to help achieve significant and measurable improvements in Europe’s environment.

The EEA aims to support sustainable development and to help achieve significant and measurable improvement in Europe's environment through the provision of timely, targeted, relevant and reliable information to policy making agents and the public.

6.3.1 The Eionet[26]

The European environment information and observation network (Eionet) is a partnership network of the EEA and its member and cooperating countries. The EEA is responsible for developing the network and coordinating its activities. To do this, the EEA works closely together with the National Focal Points (NFPs), typically national environment agencies or environment ministries in the member countries. EEA membership and participation

The EEA now has 32 member countries and six cooperating countries. The 32 member countries include the 27 European Union Member States together with Iceland, Liechtenstein, Norway, Switzerland and Turkey.

The six West Balkan countries are cooperating countries: Albania, Bosnia and Herzegovina, Croatia, the Former Yugoslav Republic of Macedonia, Montenegro and Serbia. These cooperation activities are integrated into Eionet and supported by the Community’s financial

[26] http://www.eea.europa.eu/documents/eionet_connects/eionet_web-en.pdf

http://www.eea.europa.eu/documents/strategy-docs/strategy

http://www.eionet.europa.eu/wiki/documents/eioneabc_connects/eionet instrument for the pre-accession process for the period 2007-2013 - Instrument for Pre-Accession Assistance (IPA).

EEA member countries that are not European Union Member States but share the concern of the European Union and its Member States for the objectives of the Agency, have the same rights and duties as the Member States, with the exception of the right to vote in the EEA Management Board.

6.3.2 The Shared Environmental Information System (SEIS)

SEIS is a collaborative initiative of the Commission and the EEA together with the MS to establish an integrated, shared and sustained information system for environmental information in Europe serving in the first instance two main purposes:

- improve the sharing of environmental data and information (or data impacting environmental policies) within Europe and provision of services to public policy makers and citizens;
- offer to MS and EU institutions an efficient reporting system to fulfil their reporting obligations related to Community environmental policies and legislation, avoiding duplication of efforts, overlapping and redundancies.

This concept seeks to capitalise on existing information and systems in the EU Member States and at the European level, consolidating them into an integrated and sustained information system. The intention is not to develop a new "information system" from scratch, but rather to benefit from existing activities.

7 Initial set of KPIs

The KPIs and related issues identified in the preceding three sections form the basis for the selection of KPIs, which is the subject of the present section. The selected KPIs are presented in a concise manner here, while some relevant supporting details are placed in Appendices at the end of the report.

7.1 The selection process

Each partner in the task group contributed to a gross list of performance indicators that were later categorized into different groups and thereafter filtered following detailed discussions. The results of the categorization, prime review and filtering are presented in headings 7.2-7.6 below.

The criteria for the selection of KPIs are dependent upon what we aim to use the KPI for. In the impact assessment document of the Freight Transport Logistics Action Plan from the Commission it is stated that:

"Both trends, the economic and the environmental, call for the mobilisation of untapped efficiencies in logistics in order to make more judicious and more effective use of freight transport operations."

Through the TEN-T programme, work is on-going to implement a set of priority transport corridors crossing Europe. The SuperGreen KPIs could potentially be useful in the search for measures that improve transport logistics so that they meet with the sustainable development goals of the European Union. The KPIs should be relevant for the different groups of stakeholders in supply chains and for all surface transport modes.

During an internal workshop held in Gothenburg in May 2010, the partners in the Task 2.2 workgroup met and addressed the issue of KPI selection. The steps followed were:

- Initial overview of the list of KPIs.
- Discussion and agreement about suitable major KPI groups. After discussion, it was decided that these major groups should be:
  - Efficiency
  - Service quality
  - Environmental sustainability
  - Infrastructural sufficiency
  - Social issues
- Preliminary allocation of KPIs into the major KPI groups.
- Detailed discussions about the KPIs within each KPI group taking into account:
  - the KPI objective, i.e. what to measure, and
  - the KPI value calculation formula.
- Distribution of tasks and time line for KPI definitions and descriptions.

Before moving on to discuss the five major KPI groups in some detail, we need to make a note on the terminology used. Descriptions of a supply chain are done in a plethora of ways. For the corridor description used in this report the following terminology is used:

Node. This is a place where goods are loaded, discharged, transhipped or moved from one mode of transport to another.

Loading node. This is the origin of the goods, i.e. where the goods are loaded onto the initial mode of transport.

Discharging node. This is the destination of the goods, i.e. where the goods are discharged.

Link. This is the stretch between nodes, i.e. where the goods are transported.

Shipment. The transport of goods from the loading node to the discharge node.

7.2 Efficiency

The “Efficiency” KPI group deals with traditional economic costs, as these are reflected in the logistics operation. In that sense, the following alternative KPIs are envisaged:

- Absolute unit costs
- Relative unit costs

KPI: Absolute unit costs
Formula: Total direct transport cost/Quantity

Input variables	Unit
- Goods quantity	ton
- Total direct transport cost	€
- Loading node costs	
- Link costs	
- Transhipment node costs	
- Discharging node costs	

KPI: Relative unit costs
Formula: Absolute costs/Distance

Input variables	Unit
- Goods quantity	ton
- Total direct transport cost	€
- Loading node costs	
- Link costs	
- Transhipment node costs	
- Discharging node costs	
- Distance	km

Absolute unit costs are used for comparisons of transport solutions on the same route. Relative unit costs are used for comparisons of transport solutions either on different routes within the same corridor, or on different corridors.

7.2.1 Absolute unit costs

Absolute unit costs are expressed in € per ton for the entire stretch from the origin (loading node) to the destination (discharging node). Good arguments can be made that for some goods types the unit should be € per m^3. For the purposes of transparency and benchmarking, ton will be the preferred unit.

The total direct transport costs are needed for the entire stretch. These are then to be divided by the quantity of goods in order to arrive at the absolute unit cost per ton.

Actual costs are always preferred as input data provided they are collected in a coherent and transparent way. This information is quite often difficult to obtain. Therefore, we are forced to rely on one or more cost calculation models using representative values.

Cost calculator tools, as described in Section 4.8, provide both data and the instrument to facilitate the calculation. A formal assessment of the available tools is necessary prior to selecting those that will be used in corridor benchmarking.

7.2.2 Relative unit costs

Relative unit costs are expressed in € per ton-kilometre for the entire stretch from the loading node to the discharging node.

Relative unit costs are arrived at by dividing the Absolute unit costs by the Distance of the entire stretch.

In terms of which stakeholders would have a stake in this set of KPIs, this obviously includes carriers, shippers, logistics operators, terminal operators, producers and consumers at large. It is hard to identify a stakeholder group for which this set of KPIs is not important. Perhaps environmental stakeholders would consider this group of KPIs of lesser importance (vis-à-vis environmental criteria), but this does not mean that they are irrelevant.

7.3 Service Quality

The “Service Quality” KPI group deals with attributes that define quality of service, as these are reflected in the logistics operation. In that sense, the following KPIs are envisaged:

- Transport time
- Reliability (time precision)
- ICT applications
- Frequency of service
- Cargo security
- Cargo safety

KPI: Transport time
Formula: Hours from start of loading at origin to end of discharging at destination

Input variables	Unit
- Total time	hours

KPI: Reliability (time precision)
Formula: Percentage of shipments delivered on time

Input variables	Unit
- Total number of shipments	number
- On-time deliveries	number/%

KPI: ICT applications
Formula: Average of assessment of availability

Input variables	Unit
- Availability of tracking service	
- In nodes and links	graded scale
- Integration & functionality	graded scale
- Availability of other ICT services	
- In nodes and links	graded scale
- Integration & functionality	graded scale

KPI: Frequency of service
Formula: Number of services per week

Input variables	Unit
- Services per week	number

KPI: Cargo security
Formula: Number of incidents/Total number of shipments

Input variables	Unit
- Total number of shipments	number
- Incidents	
- Serious	number/%
- Non-serious	number/%

KPI: Cargo safety
Formula: Number of incidents/Total number of shipments

Input variables	Unit
- Total number of shipments	number
- Incidents	
- Serious	number/%
- Non-serious	number/%

7.3.1 Transport time

Transport time refers to the total time in hours or days, from loading at the origin to discharging at the destination. An alternative way for measuring transport time is the average speed for the same route.

The BE Logic project defined “Time” along the supply chain as the sum of:

- Loading time (days, hours, minutes)
- Driving/sailing time (days, hours, minutes)
- Unloading time (days, hours, minutes)
- Waiting time at borders, terminals, etc. (days, hours, minutes)

In the business of supply chain management the “lead time” concept prevails and comprises the time from the call of the order to the final sign-in of the consignee.

7.3.2 Reliability (time precision)

Reliability is a KPI often brought forward as important.

The reliability indicator in the BE Logic benchmarking tool (see Section 4.1.8) is defined as the mean of:

- Punctuality (scale 1 to 5)
- Transit time variation (scale 1 to 5)
- Reputation (scale 1 to 5
- Complaints (scale 1 to 5)

The related quality objectives of the Brenner corridor, as defined in the Bravo project (refer to Section 5.1.1), concern punctuality (maximum delay of 15 min for 90% of the trains) and transit time variation (maximum train delay of 180 min for the 10% non-punctual trains).

For the sake of simplicity, here the indicator is expressed as the percentage of on-time deliveries. Reliability describes the relation between expected and actual transport time. For each individual route and transport solution there has to be a definition of what is to be regarded as “on-time”, i.e. how much delay is acceptable.

For each transport solution within each corridor the total number of shipments is needed as is the number thereof that has been performed “on-time”. In several cases it is likely that the percentage is available at source, which of course is equally useful.

Expected values of this indicator should be:

- Road transports: >95% of all deliveries on time (depending on OTD definition by day or hour)
- Rail transports: >80% on time for German rail transports, >60% on time for international rail transports in Europe. Rail transport is a very volatile mode in terms of reliability as it is closely linked to national rail tracks and national supervision. Delays in one country are not quite likely to be compensated in another country. As a consequence, delays accumulate proportionally to border crossings. In addition, in most cases passenger rail transports enjoy priority.
- Ocean shipping: 70% on time. Weather conditions and port congestions along a 15-30 days transcontinental trip make ocean shipping more vulnerable to delays than comparable modes.

7.3.3 ICT applications

The presence and degree of sophistication of applications of information and communication technology (ICT) is important from several aspects. From an operational point of view it is about planning. From a view of shifting transports towards more sustainable alternatives it is about facilitating change and efficiency improvements.

ICT applications cover a wide range. Therefore, this KPI is the assessed result of four performance indicators which broadly reflect the presence and degree of sophistication of the availability of goods tracking services as well as of other relevant ICT services.

The assessment is the average of numbered, graded scales describing first the presence in terms of "non-existent" to "full coverage of transport stretch", then the degree of integration and functionality in similar terms.

To summarize, the performance indicators are:

1. *Availability of tracking services on nodes/links*
2. *Integration & functionality of tracking services*
3. *Availability of other ICT services on nodes/links*
4. *Integration & functionality of other ICT services*

Initially, it is suggested that the KPI selection is limited to the tracking services. The other services are important, but for reasons of feasibility the limitation is suggested for the moment. It is expected that the "other ICT services" indicator will be defined later on, once sufficient input from SuperGreen Work Package 4 (Smart exploitation of ICT flows) becomes available.

For any instance of the previous KPIs, i.e. tracking services or other ICT applications, the procedure to grade their availability, integration and functionality can be achieved as discussed below.

The grade for availability and integration/functionality is related to the percentage of how much the whole corridor is covered by ICT. Inherently, each corridor consists of segments that join together different nodes, the latter corresponding to a port, city, etc. Each segment is assigned with a grade of IC technologies existence and an average grade for the whole corridor is evaluated. To achieve results' diversity and reduce the complexity in grades' assignment, a scale of 1 to 5, with a minimum step of 1 grade is adopted.

Grade 5 expresses the existence of pores at an acceptable percentage compared to the current technology achievements and products available in global market for ICT applications.

7.3.4 Frequency of service

The frequency of service describes the number of shipments available per week for each individual transport solution.

As frequency is closely related to flexibility of a transport the BE Logic KPI definition shall be equally considered. It is a composite indicator involving the following:

- Ability to adapt to changes in demand/volume (scale 1-5)
- Ability to adapt to changes in size / special cargo (scale 1-5)
- Ability to adapt to changes in time table (time needed to return to normal conditions / response time)
- Robustness, ability to cope with serious disruptions like cancellations, strikes, etc. (scale 1-5)
- Availability, possibility to have custom made departure times (yes/no)
- Availability of fixed time tables (number of departures per week)

7.3.5 Cargo security

Cargo security is about damage due to unlawful acts such as thefts or roadside robbery. Different transport modes have different security levels which are measured qualitatively in terms of degree of security.

The usual way to evaluate performance of a transport solution in terms of cargo security is through a result-oriented approach that involves measuring the security incidents and comparing them to the total number of shipments.

A different approach is followed by Marintek (2008) in the Shipping KPI project. A prevention-oriented approach has been selected for this project. As presented in Appendix I, the cargo security performance of a ship is described by an index that takes into consideration crew- and port state control-related aspects in addition to security deficiencies recorded during external inspections of the vessel.

However, the Marintek approach requires detailed and sensitive data on carrier level, which is deemed extremely difficult for a benchmarking application at corridor level. As such, we propose the usual result-oriented approach and express the cargo security KPI through the following formula:

$$\text{Cargo Security KPI} = \frac{\text{Number of Shipments sub.to. Security Incidence}}{\text{Total number of shipments}}$$

For each transport solution within each corridor the number of shipments that have been subject to a security incident will be presented in relation to the total number of shipments. The security incidents are to separate between serious and non-serious incidents wherever possible. Also here it is likely that the percentage is available at source.

7.3.6 Cargo safety

Cargo safety refers to incidents that result in the damage of goods transported. The approach to cargo safety is the same as that of cargo security.

Here, Marintek (2008) expresses the cargo safety performance of a ship through an index that combines the results of safety incidents with relevant prevention measures. The crew- and port state control-related aspects of the index are identical to those of the cargo security index discussed above. Furthermore, the safety index depends on fire and explosion, navigational, equipment failure, and cargo incidents, in addition to fatalities, injuries, lost workdays and safety deficiencies recorded during external inspections of the ship. For more details refer to Appendix II.

Once again, the result-oriented approach is preferred on the grounds of data availability, and the following formula for the cargo safety KPI is employed:

$$\text{Cargo Safety KPI} = \frac{\text{Number of Shipments sub.to. Safety Incidence}}{\text{Total number of shipments}}$$

Also here it is likely that the KPI values are available at source.

As before, in terms of which stakeholders would have a stake in this set of KPIs, again this includes carriers, shippers, logistics operators, terminal operators, producers and consumers at large. As previously, it is hard to identify a stakeholder group for which this set of KPIs is not important, even though obviously the weight this set of KPIs carries can vary among stakeholders.

7.4 Environmental Sustainability

The "Environmental Sustainability" KPI group deals with environmental attributes, as these are defined in the logistics operation. In that sense, the following KPIs are envisaged:

- Greenhouse gases (carbon footprint)
- Polluters

KPI: Greenhouse gases

Formula: Total CO_2 emission/Goods quantity*Distance*1,000,000

Input variables	Unit
- Goods quantity	ton
- Distance	km
- Total CO^2 emissions (equivalent)	ton

KPI: Polluters - NO_X

Formula: Total NO_X emission/Goods quantity*Distance*1,000

Input variables	Unit
- Goods quantity	ton
- Distance	km
- Total NO_X emissions	kg

KPI: Polluters - SO_X

Formula: Total SO_X emission/Goods quantity*Distance*1,000

Input variables	Unit
- Goods quantity	ton
- Distance	km
- Total SO_X emissions	kg

KPI: Polluters - $PM_{2.5}$

Formula: Total $PM_{2.5}$ emission/Goods quantity*Distance*1,000

Input variables	Unit
- Goods quantity	ton
- Distance	km
- Total $PM_{2.5}$ emissions	kg

7.4.1 Greenhouse gases (carbon footprint)

The selected KPI for greenhouse gases is the emissions of CO_2-equivalent, as it takes into consideration emissions of other than CO_2 greenhouse gases. The unit is grams of CO_2 per ton-km. It is noted that emissions themselves were preferred to estimates of the relevant external costs as an indicator in order to decouple corridor assessment from the fluctuations and uncertainties involved in the valuation of the price of a tonne of CO_2, something that may fluctuate in time.

Following the NTM logic on system boundaries (refer to Section 4.5), the system boundary B (well-to-wheel) is selected for this application, provided of course that the necessary data is readily available.

The selected KPI is in reality a composite indicator, its value being produced from the values of three PIs according to the formula:

Specific emissions of GHG = (Fuel Emission Factor)(Specific energy consumption)/(load factor)*

where:

- **Fuel Emission Factor** is expressing emissions of GHG per energy unit of fuel and is measured in grams CO_2-eq/kWh. It depends on the type of fuel being used. For traditional liquid fuels specific emissions depend only on the fuel used and CO_2-eq emissions are almost identical to those of CO_2 (emissions of methane are negligible); for gaseous fuels there is also a technology element influencing emissions (unburned methane may be emitted, so called methane slip) and methane should be included in the CO_2-eq with a factor of 21[27].
- **Specific Energy Consumption** is expressing the energy input to the vehicle (or vessel) per travelled distance and is measured in kWh/km. The specific energy consumption is influenced by engine and vehicle technology, driving conditions (speed, congestion, topography, weather, driving pattern etc) and by load factors[28].
- **Load factor** is expressing the cargo load in tons in relation to the capacity of the vehicle/vessel and can be expressed as ton-km/vehicle-km. Another term for load factor is capacity utilisation factor.

All three PIs entering the above KPI formula are very important for the SuperGreen project:

The **Fuel Emission Factor** provides a picture of the fuel types being used along the corridor. The requirement of the Freight Transport Logistics Action Plan regarding the availability of alternative fuels (like bio-diesel) along green corridors is covered by this indicator. The provision of electricity charging stations, which appears in the technical specifications of modern highways is also of relevance here.

The **Specific Energy Consumption** expresses the technological vintage employed by the vehicles/vessels using the corridor, as well as by the corridor infrastructure itself. Work Package 3 (Sustainable green technologies and innovations) is devoted to this subject and is expected to have valuable input in this respect. This is also a field seriously affected by legislation both at the European level (technical requirements imposed on new vehicles / vessels), and at the Member State / regional level (restrictions/bans applied on certain types of infrastructure for specific transport means).

The **Load Factor** proves to be the single most crucial parameter when it comes to environmental performance of a transport chain (see Figure 7 in Section 4.5). The implications of load factor on the efficiency of a transport solution are also evident.

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[27] The global warming potential of methane in a 100 year perspective as estimated by UNFCCC.

[28] The Energy Efficiency factor may also be influenced by fuel choice (for example Heavy Fuel Oils vs. Marine Diesel Oil in ships), but since this effect is relatively limited it is rarely taken into consideration.

In view of the above, an attempt will be made to reach the KPI values for greenhouse gases through examination of the abovementioned three PIs. Only in the case that this proves infeasible due to lack of reliable data, we will turn to emission calculators such as the NTM-calc and EcoTransIT tools presented in Section 4.

7.4.2 Polluters

The assessment of the KPIs for polluters with local and regional effects is done in the same way as greenhouse gases. The indicator is specific emissions of the polluters NO_X, SO_X and $PM_{2.5}$[29]. More specifically:

Nitrogen Oxides: grams NOx per ton-km (NOx covers NO and NO_2)

Sulphur Oxides: grams SOx per ton-km (SOx covers SO_2 and SO_3)

Particle matter PM: grams $PM_{2,5}$ per ton-km ($PM_{2,5}$ is the fraction of PM with a size below 2.5 micrometers)

For heavy vehicles, ships and trains specific emissions are usually given in grams per kWh engine power (NOx and PM)) and have to be transformed to emissions per ton-km through using energy efficiency data and load factors similar to those used for GHG above. Note that the gram per kWh in this case usually refers to the energy output of the engine, not the energy input as for GHG. Sulphur emissions are most commonly communicated through data on sulphur content in fuels and can be transformed to grams/ton-km.

- Specific Emissions of NOx are mainly dependant of engine technology, although some differences can be attributed to fuels (relevant mainly for shipping).
- Specific Emissions of SOx vary with the sulphur content in fuels. For road diesel there is a common standard (10 ppm) within EU; for ships the sulphur content may vary from below 1000 ppm (0,1%) (ships at berth in community ports and inland waterway vessels) to over 20.000 ppm (ships using heavy fuel oil outside Sulphur Emissions Control Areas (SECAs)).
- Specific Emissions of PM depend both on engine technology and on the fuel used and increase with sulphur content.

The formulas used to calculate the specific emissions will have to vary depending on data sources and data format, so only one example is given here:

Specific emission of NOx[gr/tonkm] = (Specific Emission Factor[g/kwh-engine[30]])(specific energy consumption [kwh-fuel/km])* (engine efficiency[kwh-engine/kwh-fuel]) /(load factor [tonkm/km])[31]*

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[29] For further reference to the various environmental consequences of the emissions as well as to an overview of policies and mitigation initiatives, please refer to the transport, environment and health factsheet available here: http://www.umwelt.nrw.de/umwelt/umwelt_gesundheit/pronet/transport/index.php

[30] "kWh-engine" refers to the energy output of the engine (or on the wheels of a car); "kWh-fuel" refers to the energy input in the fuel to the engine.

[31] The abovementioned environmental performance indicators can be used as KPIs directly or after grouping and aggregating in monetary units through valuation of external cost (see Handbook on the estimation of external cost in the transport sector http://ec.europa.eu/transport/sustainable/2008_external_costs_en.htm).

Obviously among the group of various stakeholders, environmental groups and society at large are those with the highest stake in these KPIs. Individual carriers, shippers, logistics operators, and terminal managers would a priori appear to have a lower stake, particularly if the external costs of emissions are not reflected in the price these stakeholders pay to operate. In that sense, if these external costs are not internalized, some operators may not behave in a way consistent with optimal environmental performance. Of course, in the event required levels (maximum or minimum) of these KPIs are mandated, either by legislation or otherwise, operators would have to change their behaviour and adapt, although the precise way this would be realized is subject to analysis. It is also entirely possible that at least some operators would try to follow and use such KPIs without being forced to do so, in the context of increasing the 'quality' dimension of their service.

7.5 Infrastructural Sufficiency

The "Infrastructural Suffieiency" KPI group deals with infrastructure attributes. In that sense, the following KPIs are envisaged:

- Congestion
- Bottlenecks

An additional indicator concerning the energy balance of the infrastructure can be considered for inclusion. It compares the energy produced (mainly through renewable energy sources) against the energy consumed during operation on an annual basis. It basically concerns ports and inland terminals, but can also be applied on new road and rail projects. A decision on this indicator will be taken following feedback from the stakeholders and the project's Advisory Committee.

KPI: Congestion

Formula: Time lost (hours)/Goods quantity*Distance

Input variables	Unit
- Average delay	hours
- Goods quantity	ton
- Distance	km

KPI: Bottlenecks

Formula: Average of assessment

Input variables	Unit
- Bottlenecks	
- Graded scale; type, serious's number	

7.5.1 Congestion

Congestion is the other important component of transport related external costs, which when it comes to road transport is even more significant than emissions.

There are different approaches in literature to measure congestion. They include:

- travel time (or speed) based indicators

- traffic volume based indicators, or
- area based indicators.

Examples of KPIs are the following:

- 'Total delay' to 'volume of traffic' ratio: Gives the "average amount of delay" for a vehicle travelling one kilometer.
- Speed-based KPIs which are especially relevant for motorways (e.g., a congested state exists when the traffic speed is below 70 kph).
- The 'congestion reference flow', an index based on the capacity of the road, number of lanes and other traffic related variables.
- The 'level of service' indicator, a basic congestion scale running from A to F (with A being best and F being worst) that describes conditions using variables such as speed, travel time, disruption to flows and safety. It is widely used in the USA.

More details on these indicators can be found in Appendix III.

For the purpose of corridor benchmarking, it is simpler to base the relevant indicator to average delay time (hours) in absolute terms. In relative terms, the indicator can be either the ratio of average delay over total transport time, or the ratio of average delay over the relevant transport work (in ton-km).[32]

Alternatively the indicator can be expressed in money terms (as average external cost), if the average delay is multiplied by a proper 'value of time' (estimates for European countries can be found in Maibach et al (2008)). It is noted that this indicator cannot be used for pricing purposes, where the measure of marginal external costs is necessary.

7.5.2 Bottlenecks

The KPI for bottlenecks is the assessed result of an inventory of different types of bottlenecks per transport solution, which are further divided into a few categories reflecting the seriousness of each type of bottleneck.

The objective of this KPI is to find the biggest bottlenecks per transport mode within corridors and estimate the seriousness of these bottlenecks. The target is to survey the development of the bottlenecks in time in different transport corridors.

For example in the TEN CONNECT study different types of bottlenecks were identified. Based on sources like this, bottlenecks and other problems related to rail, road and port/terminal infrastructure can be identified for each corridor, taking into consideration geographical and environmental aspects. This data can be combined with information on ongoing and planned projects addressing removal or diminishing the bottlenecks. The data on the number of the development projects serves as an assessment of the seriousness and persistence of the bottlenecks.

[32] In this and other indicators it might be necessary to multiply its value by a proper force of 10 in order to bring it to managable ranges.

First all major bottlenecks will be defined for each corridor. This will give the numerical value of total number of bottlenecks along a corridor. The bottlenecks can be divided into three different categories in order to identify different bottlenecks. The categories are:

1. Infrastructure
2. Capacity
3. Geography

Bottlenecks related to infrastructure describe how many sections of transport infrastructure is in bad condition along the corridor.

Bottlenecks related to capacity describe how many sections exist where are capacity problems (traffic jams, customs, insufficient port or rail capacity etc.).

Bottlenecks related to geography describe how many geographical barriers exist along the corridor (ice conditions, mountains etc.).

In addition to these categories different transport modes should be taken into consideration. Table 7 below shows how this can be presented.

Table 7. Number of bottlenecks

	Infrastructure	Capacity	Geographical
Road			
Rail			
Sea (incl. Ports)			

Next step is to calculate the number of ongoing and planned infrastructure development projects aiming to remove or diminish the bottlenecks. This number describes the seriousness of the bottlenecks in the long term.

Table 8. Number of infrastructure development projects. Seriousness.

Corridor Name	Road	Rail	Sea (incl. Ports)

Again the data should be divided based on transport mode in order to easily identify and quantify the projects. For getting more detailed information different sub categories can be formed for certain bottlenecks (toll operations etc.) depending on the nature of the transport corridor in question. This KPI requires the survey on the bottlenecks and updating this information at yearly basis.

Obviously most stakeholders would consider this set of KPIs important, but more so infrastructure operators and users, and most notably those who are asked to pay for infrastructure construction and maintenance.

7.6 Social Issues

Last but not least, the "Social issues" KPI group deals with issues likely to impact society in a broader sense. In that sense, the following KPIs are envisaged:

- Corridor land use
- Safety
- Noise

KPI: Corridor land use

Formula: Share of total distance

Input variables	Unit
- Share of total distance that are:	
- Natural sensitive	Percent
- Urban	Percent

KPI: Traffic safety

Formula: Number of incidents/Total number of shipments

Input variables	Unit
- Total number of shipments	number
- Incidents	
- Serious	number
- Non-serious	number

KPI: Noise

Formula: Share of total distance

Input variables	Unit
- Share of total distance where:	
- Noise level is <50dB (55)	Percent
- Noise level is ≥50dB (55)	Percent

7.6.1 Corridor land use

When it comes to land use, there is a plethora of indicators in the literature, the most prominent of them being:

- Size, density and proportion of population living along the corridor
- Percent of built-up land by distance from the median line of the corridor
- Percent of new development on "brownfield" (previously developed) land
- Percent of land taken by agriculture
- Percent of land being areas of semi-natural habitat
- Percent of land protected by statutory designations

- Rate of loss of, or damage to, protected areas
- Changes to significant habitats and species
- Employment by economic activity, employment status and place of work
- Degree of social inclusion (indices of deprivation, like unemployment rate)
- Household prosperity (average annual earnings, value of residential property, proportion of population with a higher education qualification)
- Volume of litter collected per given length of corridor
- Amount of oil pollution (for rivers and coastal areas)
- Rate of soil erosion

For the purpose of corridor benchmarking, it was decided to focus our analysis to urban areas (due to their significance in terms of transport related external costs) and environmentally sensitive areas (due to potential effects on nature and endangered species). It is believed that these two aspects combined provide a sufficiently good picture of the land use related external costs that transport activities impose on the general public.

The first step in forming the urban land KPI is to define different land use categories along the corridor under examination. In order to get homogeneous data related to land use aspects, calculations on the urban land can be made using the CORINE Land Cover spatial dataset. Within a buffer radius of 20 kilometres from the median line of each corridor, the total area of urban land cover can be calculated and this will be put in relation to the total area of corridor occupied land. The radius of 20 kilometres is used in order to include the major parts of even the largest cities along the corridors and in order to take into account the fact that transports are, in part, distributed to areas around the defined corridors.

The following land use groups of the CORINE Land Cover dataset are defined as urban areas for the purpose of the calculations.

Table 9. The urban land use groups used in the analysis

Class defined by SITO	GRID_CODE	CLC_CODE	LABEL3
Urban	1	111	Continuous urban fabric
Urban	2	112	Discontinuous urban fabric
Urban	10	141	Green urban areas
Urban	11	142	Sport and leisure facilities

For each corridor with a 20 km radius, a total buffer zone in square kilometres will be calculated after subtracting the areas consisting of waters and those areas not covered by CORINE. The surface covered by urban areas within the buffer zone will be calculated and then divided by the total area of the buffer zone. In this way, a comparable index for urban land can be calculated for each corridor: the share of urban areas in the vicinity of each corridor.

However there are some restrictions in the calculations made in this way. The CORINE Land Cover datasets for Europe do not cover countries outside the EU. Thus, the calculations will not reflect for example the land use in countries such as the Russian Federation. Also, the calculations produce higher values for corridors that consist only or mainly of sea connections, requiring a special treatment. The reason is that only land areas around ports are included in the calculations, while the long sea segments are excluded. On the contrary, the buffer zones of land-based corridors include large rural and inter-urban areas, resulting in smaller ratios when compared to those of the maritime corridors.

The Natura 2000 spatial dataset available from the European Environment Agency can be used for calculating the sensitive areas KPI, in a way similar to the CORINE Land Cover dataset, used for urban areas. Natura 2000 is the key instrument to protect biodiversity in the European Union. The data was published in February 2010 and covers the EU, excluding the United Kingdom, Northern Ireland and Austria. Natura 2000 network does not cover non-EU-countries.

The share of Natura 2000 areas as a percentage of the total buffer area within the 20 km radius will be calculated along each corridor, thereby producing a comparable index for sensitive natural areas. Natura 2000 areas also include the areas with endangered species.

7.6.2 Traffic safety

Safety here refers to the incident rate of accidents and/or fatalities. The approach is similar to the KPI for cargo safety. The unit is percent over the total number of shipments. Alternatively, relative values can be expressed as percent over transport work (ton-km) as suggested by the NTM model (refer to Section 4.5).

For each transport solution within each corridor the number of shipments that have been subject to an accident will be presented in relation to the total number of shipments. A problem that may arise with this indicator might be the differences that exist between the definitions of what constitutes an “accident” that apply on the different transport modes. Refer to Appendix IV for more details. An alternative indicator that bypasses this potential problem is to focus on the results of the accidents; namely fatalities and serious injuries. Should this approach be followed, the indicator could be the sum of deaths and serious injuries over either total number of shipments or total transport work..

7.6.3 Noise

Noise pollution is commonly defined as the excessive or annoying degree of unwanted sound in a particular area. The “Environmental Noise Directive” (END), relating to the assessment and management of environmental noise was adopted by the European Parliament and Council in 2002. This Directive guides and steers activities on noise in Member States. Appendix V presents in more detail noise related KPIs.

The acceptable noise level is set to 50 dB except for trains which is 55 dB. The unit for the KPI on noise is percent of the total distance that is exposed to noise levels above the 50/55 dB limit. There are available figures in existing databases.

It is clear that the populations of citizens affected (either directly or indirectly) by transport logistical developments are the main group of stakeholders mostly interested in these KPIs. All other groups of stakeholders are believed to consider these KPIs important, but perhaps less than other KPI groups.

7.7 Further filtering of the KPIs

The process of identifying the final set of SuperGreen KPIs is based on what has been described previously in this deliverable. It is also important to revisit the objectives of this report:

> *"This document presents the Key Performance Indicators (KPIs) to be used in the analyses of transports that concern the EU area directly or indirectly. The KPIs should be instrumental in the search for measures that improve transports so that they meet with the sustainable development goals of the European Union.*
>
> *The KPIs should include the different groups of stakeholders in supply chains and all surface transport modes".*

There are two (or three) main elements inherent in the sustainability concept; efficiency and environment. The latter comprises negative externalities affecting both the nature (emission to air and influence on land/sea), and the impact transport operations has on humans and infrastructure (noise, accidents, etc.).

According to the DoW, one or two main KPIs should be identified and chosen from each group in order to make out the final group of KPIs. Currently, the KPI group having the largest number of KPIs is "Service quality" with six KPIs. However, it is not certain that fulfilling the above 'requirement' is reasonable if one is to develop a set of KPIs that supports the project objectives (contributing to the development of sustainable and green transport corridors). Elements from previous sections in the report is revisited and applied in this evaluation for selecting the final set of KPIs for benchmarking purposes in the further work in SuperGreen. Important aspects to keep in mind when suggesting final KPIs are:

- Avoid too many different indicators
- Data availability (necessary data should be available without big investments).
- Sharing of data; companies should be willing to share necessary information with other parties.
- KPIs should be easy to communicate and understandable
- Amount of work for keeping the benchmark up-to-date should be reasonable.
- KPIs should be useful, in the sense that they should contribute to the ex ante defined aim of the benchmarking, and that the derived results can lead to improved performances.
- Organizations using the benchmarking results should be able to influence the KPIs in a favorable way; otherwise the learning benefit would be missing.

In addition, there are some questions that need to be answered for designing a successful benchmarking process:

- Why should the benchmarking be carried out?
- Who are the users carry out the benchmarking?
- Who are the beneficiaries of the results?
- Which processes are to be benchmarked?
- What information (KPIs) is required?
- Who will provide the data?

The current list of KPIs in SuperGreen covers the above mentioned criteria in a good manner, and the derived KPIs seem to fulfill the project objectives. However, to conclude on a manageable set of KPIs it is necessary to keep the number to a minimum. The KPIs should also be useful for improving the greening potential of benchmarked corridors according to the overall goals of the EU. The Task 2.2 partners have produced a table that represents a first iteration towards a final suggestion of a set of KPIs to be further pursued by the project. This table was presented for discussion at the Naples workshop on Oct. 19, 2010 and also put forward for feedback by the project's Advisory Committee (AC meeting on Oct. 26, 2010 in Brussels), with a view to taking it on board in the context of Task 2.4.

This table (Table 9) is presented in the following pages.

Note (among other things) the last column on data availability and measurability, which is a very important issue. The evaluation of the various sets of KPIs critically depends on the data that is available to compute them, and it may make no sense to use a specific KPI if the data necessary to compute it is elusive or of poor quality. The first test of data availability and measurability will come in Task 2.4, the benchmarking of the 9 corridors selected for further analysis.

Table 9: Further filtering of KPIs

KPI Group	KPI title	Pursue KPI or not (Y/N)	Rationale for decision	Data availability & Measurability
Efficiency	Absolute cost *(Cost of goods transported per ton)*	No	Although this it is a good and relatively easy way to measure the cost of total amount of cargo transported through a corridor, it does not relate to the efficiency of transport operations (as relative cost does by including distance).	*Measurability*: Formula for calculating the KPI is not complex, possible to aggregate up to a corridor level. Tools such as COMPASS and The NP Should calculator can produce information *Availability of data*: *Stakeholder Group*: Transport service providers and users
	Relative cost *(Cost of goods transported per tkm)*	Yes	A good measure for indicating the efficiency of the transport work performed in the corridor (Cost/ton km). This KPI also to some extent enables comparison across corridors. If the KPIs are to support the EU goals towards developing more sustainable transport operations, Relative cost is a preferred KPI compared to Absolute cost.	*Measurability*: Formula for calculating the KPI is not complex, possible to aggregate up to a corridor level. *Availability of data*:

				EuroStat on tkm, country to country. Not corridor specific. *Stakeholder Group*: Transport service providers and users
Service quality	Transport time	No	This is an important KPI frequently applied within logistics. However, within this context it is considered to be of less importance since reliability also reflects the transport service provider's ability to comply with pre-defined schedules and time-tables.	*Measurability:* Increased visibility of cost structures are needed for rail, sea and IW, but analysis can be performed by existing tools; COMPASS, *Availability of data:* *Stakeholder Group:* Transport service providers and users
	Reliability	YES	This KPI is considered more important than transport time since reliability indicates to what extent the transport stakeholder can rely on the provided service. I.e. how well the transport provider complies with pre-defined schedules and time-tables. Describing the relation between expected and actual transport time,	*Measurability:* Description of KPI is clear and the different measurements 'constructing' the KPI are

			reliability also provides an indication on cargo damage/loss (i.e. cargo safety). It also reflects the KPI measuring congestion, while also having a strong link to cargo security.	quantifiable. *Availability of data:* *Stakeholder Group:* Transport service providers and users
	ICT applications	Yes	A very important KPI and possibly one of the most important KPIs towards creating efficient and effective co-modal transport services and operations. This also supports the development of transparent intermodal transport services.	*Measurability:* *Availability of data:* *Stakeholder Group:* Transport service providers and users, governments
	Frequency of service	No	Reflects more the transport provider's ability to offer a good quality service, and not necessarily affects any greening of the corridor. Yet, frequency is related to the amount of cargo available, thus of course giving it an economic dimension. The latter being of particular importance for initiating new transport operations.	*Measurability:* *Availability of data:*

				Stakeholder Group:
	Cargo security	Yes	Contributes to economy as it affects the attractiveness' of shipping cargo through the corridor. In some instances increased cargo security can be assured by the authorities, in others it can be assured by the transport provider.	*Measurability:* *Availability of data:* *Stakeholder Group:*
	Cargo safety	No	This KPI also has an economic dimension but its "score" rests mostly upon the transport service provider to perform. Although this is an *important* KPI it is considered to be of less importance than cargo security.	*Measurability:* *Availability of data:* *Stakeholder Group:*
Environmental sustainability	Greenhouse gas (CO_2)	Yes	*General comment for this KPI Group:*	*Measurability:*

	Polluters - NOx	Yes	All KPIs within this group should be brought forward. $CO_2$is possibly the most important KPI due to the amount of attention it receives from the public and private sector. It is a clear relationship between fuel consumption and emitted CO_2, making it easy to derive. This goes for all transport modes. There is also a clear relationship between content of sulphur in the fuel and amount of emitted SOx (also supported by SECA and required fuel quality in these areas). NOx and PM are more challenging as the amount emitted depends in fuel type and engine technology. Still, there are defined emission factors that can be used in the calculations (as shown in KPI description). These factors are related to emission criteria that are to comply with; IMO/MARPOL Annex VI for sea; EURO I-VI standard engines for road; and rail the future focus should be on controlling emission from power generation. The latter due to large-scale electrification of the rail infrastructure[33] . Further, all KPIs will be largely influenced be entry of natural gas as fuel type in the corridor (although CO_2 to a less degree).In addition, all KPIs are also essential for supervising how different measures contributes to "greening" various transport corridors.	Emission to be calculated based on defined factors. Also, existing tools as mentioned in report; GIFT, IMTS calculator (CO2 specific). *Availability of data:* Dependent on volume and type of fuel actually consumed. *Stakeholder Group:* Transport providers and users, general public, and governments
	Polluters – SOx	Yes		
	Polluters – PM	Yes		
Infrastructure sufficiency	Congestion	No	This KPI is considered to be of less importance since the "bottleneck KPI" is also an indirect indication of congestion. This because average delay and average	*Measurability:* AIS data can be used to

33 http://www.eea.europa.eu/data-and-maps/indicators/specific-air-pollutant-emissions/specific-air-pollutant-emissions-assessment-2

			travel time is largely affected by the amount of bottlenecks in the corridor.	indicate and visualise traffic density for sea transport. *Availability of data:* Available in AIS databases, Land based transport(?) *Stakeholder Group:* Transport providers, governments,
	Bottlenecks	Yes	This KPI is a good approach on how to obtain an overview of bottlenecks related to the different modes of transport for the different corridors. Also for assessing the number of bottlenecks per corridor. Further, keeping such information updated over time provides a clear indication on how the efforts for minimising/ removing the bottlenecks progress. Over time, one can extract and disseminate best practices on how bottlenecks have been solved across different corridors. It also indicates the arrival of new bottlenecks. Although the amount of bottlenecks in one corridor not necessarily indicates its seriousness, and that the KPI is not presenting a final figure/number, it is possible to trace the bottlenecks in order to reveal true status. Further, the process of identifying and solving transport bottlenecks has been on	*Measurability:* Possible to identify/measure number of bottlenecks per corridor for each transport mode. *Availability of data:* Since the initiation of the bottleneck exercise in 1999, a comprehensive "repository"[36] has been established. The TEN-T Priority

			the European Commission's agenda since the Bottleneck exercise was introduced in 1999[34]. The initial focus was on SSS, but has during the last 5 years had an intermodal focus. There are also a number of ongoing 'TEN-T Priority Projects, aiming to relieve transport related bottlenecks on a pan-European basis[35]	projects are also an indication on geographical location and type of bottleneck. *Stakeholder Group:* Transport service providers and users, governments
Social issues	Corridor land use	Yes	This KPI is good in the way that it describes the corridor's impact on different environments (e.g. urban area, human area, sensitive area). From a governmental perspective, and for the greening of transport corridors, it is essential to map the level of impact transport operations has on the local environment in terms of land use.	*Measurability:* Facilitated through CORINE Land Cover spatial dataset. External cost can be calculated by COMPASS *Availability of data:* Data available for land based transport, however. Ports only included for sea transport, disfavouring corridors with long stretches of sea

34 Initiated in 1999 by the Directorate-General for Energy and Transport in the European Commission, Objective: Identification of bottlenecks that hamper the development of SSS, The identification of possible solutions to those bottlenecks, The compilation of examples of best practice in the sector

35 "TEN – T, Trans-European Transport Network, Implementation of the Priority Projects, Progress Report", June 2010.

36 http://ec.europa.eu/transport/logistics/bottlenecks/index_en.htm

				transport. *Stakeholder Group:* Governmental, general public,
	Traffic safety	Yes	The KPI is a good indication on how secure the corridor is for transport operations in general. It also serves the purpose of indicating the external cost related to traffic accidents, and by that be an important indicator on how politicians should prioritise investments for making goods and personnel transport safer.	*Measurability:* Measurable in terms of number of accidents reported. *Availability of data:* *Stakeholder Group:* Governmental, general public, transport service provider and user
	Noise	Yes	The KPI is founded in pre-defined noise-levels that are accepted on a pan-European basis. An online tool for measuring noise is also readily available. The KPI will also provide a easy indication on the extent of unwanted noise through a corridor.	*Measurability and data availability:* Existing tool for measuring noise from roads, rail and airports[37]

[37] http://noise.eionet.europa.eu/

				Also existing for seaport[38] *Stakeholder Group:* Government, general public, transport service providers

[38] (http://nomeports.ecoports.com/page.ocl?pageid=6&mode=&version=&nid=17)

In addition to this, a check was made on whether the suggested KPIs cover sufficiently the characteristics of a "green corridor" as described in the Freight Transport Logistics Action Plan. The outcome of this last check revealed that all aspects are well covered with the exception of the document's explicit requirement for "green corridors" to offer **free access** to all types of infrastructure. Therefore, this requirement has to be either considered as a prerequisite for a green corridor, or included in the KPI list as a YES/NO indicator.

7.8 KPIs vis-a-vis needs of stakeholder groups

An important element of performance monitoring is describing the value and usefulness inherent in the KPIs, and how this usefulness varies depending on the different KPIs. Key words in this context are therefore KPI 'applicability', 'usefulness', and 'implications' for the different user groups (stakeholders) directly and/or indirectly involved in the operations measured.

The KPIs identified in this report are classified in different groups, meaning that the applicability and implications for the different KPIs may vary across the user-groups. This section will therefore elaborate and discuss the different KPI groups, and some selected KPIs, in terms of applicability and long-term implications for the involved user groups.

<u>Efficiency</u>

The KPI group '*Efficiency'* embraces KPIs strictly related to the cost of transport operations carried out in a specified corridor. Since the aggregated information reveals how cost-efficient the transport operations are, they are obviously very useful to both providers and users of such services. The users can apply such information for making strategic and operational choices regarding which corridors to choose for cargo distribution. Further, since the KPIs represent a 'corridor mean' it can also be applied for making choices as to which transport provider to select. Transport providers performing above the KPI value can typically apply this information for marketing purposes, while those performing below can apply the KPI value for improving current operations. On a more long-term perspective, the KPIs are of value for policy makers and local/regional governments, since the KPIs evolvement over time is an indication on how well transport-related measures affect the cost and efficiency of transport operations.

<u>Service quality</u>

Looking at the KPI group '*Service quality*' the usefulness is most apparent for the transport user and transport provider. Viewing the KPI 'Reliability' in particular it reveals how transport provider(s) perform according to pre-defined schedules and timetables, and according to contract. For the transport provider this information is relevant for marketing purposes, and particular relevant in an intermodal setting. Being able to 'prove' reliability for potential customers is essential for any transport provider. Further, since the KPI indicates the relation between expected and actual transport time, it is one of the most important KPIs for any transport user. As mentioned in the previous section, the KPI is also a long-term indication of how well implemented transport policy instruments and measures affect the transport industry.

<u>Environmental sustainability</u>

'*Environmental sustainability'* is probably the KPI group with the widest audience compared to all identified groups. All KPIs in this group has both short-term and long-term effects on all defined user-groups; transport service providers, transport users, political sector, as well as the general public. Due to the nature of the KPIs, application and implication has to be made on a general basis for each user group:

- Transport service providers will on a short-term basis be able to utilize the various KPIs for assessing their own performance, i.e. to what extent the various transport providers perform according to the 'corridor mean'. Based on environmental regulations, and the drive towards developing increasingly energy efficient transport operations (incl. intermodal operations), this will reveal to what extent immediate and operational measures are necessary. On a more long-term basis the historic development of KPIs will provide an indication as to what extent strategic and operational measures taken results in environmental improvement or worsening. For any transport provider, being able to apply such KPIs for marketing purposes also holds a commercial value. Both towards the general public, but also towards cargo owners aiming to decrease the environmental footprint of the supply chain. Further, long-term implications of such KPIs can materialize in the following ways: stricter environmental regulations, more justified rebate systems for proven reduced carbon footprint from operations, implementation of tax regimes (e.g. road pricing), and for developing more efficient transport operations.

- The applicability of the KPIs for transport users are quite similar to the transport service provider's, since the KPIs can be applied for making short-and long-term strategic and operational transport decisions. However, the relevance of these KPIs for the transport user depends on the company's level of environmental focus, i.e. how engaged it is on greening its supply chain. Previous studies indicate that transport users consider environmental friendly transport operations as important, but as long as no official regulations or political measures are implemented, the willingness to pay any extra cost is seemingly quite low[39].

- As it can be applied for introducing new environmental measures for the transportation industry (e.g. emission standards, regulations and tax/rebate regimes), this KPI group is of significant value for the political sector. It can also be applied for introducing environmental recommendations and standards for the transport users (e.g. responsibility for environmental footprint of the complete supply chain). By surveying the development of environmental impact transport operations has over time, the KPI group can reveal the long-term effect of implemented environmental regulations (e.g. transport operations corridor specific contribution to emission of GHGs and particle matters).

- NGOs (Non-Governmental Organizations) will be able to apply the KPIs for practicing political pressure on a local level as well as on a national and pan-European level. The implications of such pressure may lead to policy recommendations and influencing the content of strategic documents issued by the European Commission (e.g. The European White Paper on Transport).

[39] PROPS Project; D

- For the general public the applicability of this KPI group is not particularly relevant. However, the long-term implications are very relevant in terms of reduced emission to air as a result of stricter regulations and transport alleviating measures.

Infrastructure sufficiency

The KPI group '*Infrastructure sufficiency'* aims to provide information on how well suited the existing infrastructure is to handle the amount goods transported through the specific corridor. The application of this KPI is most useful for transport service providers and users, and the political sector. Providers and users of transport services will apply information regarding bottlenecks for making both strategic and operational choices regarding how, when and by what mode(s) to send cargo. Long-term implications of this should be that reported transport bottlenecks receive alleviating measures, contributing to more seamless corridor transport operations. For the political sector, information regarding congestion and bottlenecks are essential for targeted funding of infrastructure projects (e.g. TEN-T Priority Projects), and further for a more strategically optimized utilization of financial resources.

Social issues

Disregarding the KPI Traffic safety, the applicability of the KPI group 'Social issues' is most likely to be of less relevance to transport service providers and users, however depending on regulations and traffic alleviating measures the long-term implications may be significant. Since the KPI Traffic safety is an indication of the external cost related to traffic accidents (affecting reliability and damage to goods), the KPI is of relevance for both provider and user of transport services. Overall this group is mostly relevant for the political sector and the general public. The political sector can apply the information for developing and introducing alleviating measures to reduce the negative externalities deriving from transport operations, while the long-term implications for the general public can be reduced impact of transport operations (e.g. reduced number of traffic accidents, less noise pollution and protection of sensitive land areas).

The above examples on applicability and implications of KPIs on the different user groups are not to be regarded as exhaustive. It is a quite complex exercise to perform a detailed separation and identification of the different user needs. Adding to the complexity is the variation in needs over time, e.g. the short term usefulness for a certain groups versus the longterm implications. Thus, it is important to continue the discussion and look into this issue also in other parts of the SuperGreen project. It is therefore recommended that further elaboration on the user needs should be pursued as the project gain more knowledge on different areas.

It is expected that the weights of various KPIs would be different for different groups of stakeholders. What may be more important for citizens living along a major motorway is expected to be different from what a trucking company using that motorway may consider important. The table below (Table 10) summarises the different interests of the various groups of stakeholders in supply chains. Be that as it may, the goal would be to move toward solutions for which all sets of KPIs are improved versus the status quo.

Table 10: KPI groups vs. stakeholder groups

		KPI groups				
		Efficiency	Service quality	Environmental sustainability	Infrastructural sufficiency	Social issues
Stakeholders	Transport clients, cargo owners	√	√		√	
	Transport operators	√	√		√	
	Terminal operators	√	√		√	
	Logistics service providers	√	√		√	
	Infrastructure owners	√	√		√	
	Authorities	√	√	√	√	√
	NGOs / Associations	√	√	√	√	√
	R&D institutions/ Universities	√	√	√	√	√
	General public	√	√	√	√	√

Again it should be made clear that the set of KPIs presented in this document reflects only the views of the SuperGreen consortium. A preliminary set of KPIs, as described in Sections 7.2 to 7.6, was presented at the first SuperGreen stakeholders' workshop organized in Helsinki, Finland on June 28, 2010 and was communicated to the members of the project's Advisory Committee. More feedback on the more complete set of KPIs described herein was obtained at the Naples workshop on Oct. 19, 2010 and from the project's Advisory Committee (AC meeting on Oct. 26, 2010 in Brussels). **A complete account of such feedback and its implications will be reported in version 1 of deliverable D2.4.** It is reminded that Task 2.4 is dealing with the benchmarking of the 9 selected corridors.

For the time being, the above set of KPIs is considered as **initial** and is subject to amendment in later phases of this project, as forthcoming activities in other parts of the project (and especially Task 2.4) may feed back into it. The remaining three regional workshops (Antwerp, Malmoe, Sines), all scheduled for early 2011, are expected to provide further ground for such feedback. Other tasks of the project, which were ongoing at the time of writing of this report, such as for instance Task 2.3, may be relevant here as well. So generally we expect to be able to add to the substance of this document as we move along, to the extent this is judged as appropriate. In any event, the set of KPIs will not be finalised prior to having been tested in the actual benchmarking of the SuperGreen corridors.

8 Conclusions and directions for further work

After performing a comprehensive review of the literature on related projects, best practice cases and work on related tools and methods, a set of KPIs relevant for SuperGreen was recommended. These KPIs fall into five major groups, that is,

- Efficiency
- Service Quality
- Environmental Sustainability
- Infrastructural Sufficiency
- Social Issues

A breakdown into lower level KPIs was also proposed, and a methodology for using these KPIs was suggested.

These KPIs will be used in subsequent phases of the SuperGreen project, most relevant of which is Task 2.4, which has already started.

The methodology of Task 2.4 is a natural follow on of Task 2.2 and includes, among other things, the following considerations:

1) Analysis of the corridors selected in Task 2.1 in terms of flows:

- origin/destination
- types of cargoes moved
- modes used
- routes taken
- trade imbalances (empties), etc.

2) Selection of 4-5 typical cargoes being transported along the axis. Part load break bulk should be one of them due to the special logistics requirements that this cargo imposes. Most probably, a dry bulk and a liquid bulk commodity should also be selected due to their high volume and different supply chain organization. For each cargo selected, identify a typical combination of modes/routes used. Identify also useful details like the types of vehicles used, technologies applied etc.

3) Locate the proper data sources for estimating the KPIs defined.

4) Estimate one set of KPIs for each case selected.

5) Identify obstacles in KPI estimation.

6) Suggest a way to transform the KPI values estimated at the route level to a single set of KPI values at the corridor level.

7) Suggest a way to express the set of KPI values for the corridor level with a single numerical value, the ultimate corridor KPI.

8) Perform a comparative analysis of the 9 SuperGreen corridors and draw conclusions on developing the “green corridor” concept. This is basically the objective of Task 2.5, but it is included here for the sake of completeness.

Even though this deliverable completes Task 2.2, it is clear that additional work is necessary to further investigate related issues. These include:

- Further elaboration of KPIs in order to take into consideration feedback from the stakeholders and members of the project's Advisory Committee.
- Further elaboration of KPIs in order to take into consideration input from other SuperGreen tasks.
- A full assessment of available tools for calculating costs and emissions.
- A method for transforming a set of route-related KPIs to a set of corridor specific KPIs.

Progress on all of the above will be reported in future project deliverables.

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Appendix I. Cargo security in the Shipping KPI project

According to Marintek (2008), the Shipping KPI project takes a prevention-oriented rather than a result-oriented point of view to describe the cargo security performance of a ship.

This is achieved through a Shipping Performance Index (SPI, indices of higher level of hierarchy than KPIs) named "Security Performance". As shown in Figure 32 below, this is a composite index depending on 6 different KPIs [40], taking into consideration crew- and port state control-related aspects in addition to security deficiencies recorded during external inspections of the ship.

SPI: Security Performance

Security Performance is a measure of security incidents (as described in the ISPS Code) recorded for each vessel.
A security incident is an intentional or unintentional breach of security (ref ISPS code).

Highly Relevant KPIs (H):	Relevant KPIs (L):
•A: Security deficiencies	•B: Crew management •C: Crew planning •D: Port state control detention •E: Flawless port state control performance •F: Crew behaviour

SPI Rating Formula = $\dfrac{(H*A) + (L*(B+C+D+E+F))}{(H) + (L*5)}$

Rating Parameters:
H=3
L=1

Figure 32. The Security Performance SPI (Source: Marintek)

The 6 KPIs entering the Security Performance SPI formula (with different weights, as only the Security deficiencies KPI is considered ´highly relevant´) are defined in the Figures 33 to 38 below.

KPI: Security deficiencies

Security related deficiencies, observations and non-conformances, recorded during external inspections and audits in a calendar year. Made relative to the total number of external inspections in a calendar year.
Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
•Total number of Security related deficiencies
•Total number of recorded external inspections

KPI Value Formula= $\dfrac{\text{Total number of Security related deficiencies}}{\text{Total number of recorded external inspections}}$

KPI Rating Formula= 100-(Z*KPI Value)

Rating Parameters: Z= 33,33

This KPI is part of a range of KPIs related to deficiencies that are identified during external inspections. These deficiencies are categorized depending on their nature. An example of a security deficiency can be lack of compliance to the ISPS code.

The total number of recorded external inspection is used as a denominator in all these KPIs in order to enable benchmarking between vessels that are subject to a uneven number of external inspection.

Figure 33. The Security deficiencies KPI (Source: Marintek)

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[40] The website of the Shipping KPI project presents a revised formula for the Security Performance SPI.

KPI: Crew management	
The KPI measures the ship management organisation's ability to acquire and maintain the required competence/crew for their operations. Measured per calendar year. Measured as a company KPI for internal improvement as well as external communication (input to SPIs)	
Relevant PIs: •D: Training days •E: Officer working days •F: Number of new cadets •G: Average number of vessels under management •H: Officer retention rate	
KPI Value Formula=	$A * \frac{D}{E} + B * \frac{F}{G} + C * H$
KPI Value Parameters:	A=60,83 B=2 C=4
KPI Rating Formula=	(Z*KPI Value) - 100
Rating Parameters:	Z= 35
This KPI combines the training effort, ability to have new cadets onboard and the officer retention rate to express crew management capability of the ship manager. Due to the different score-range for the three ratios, three value parameters (A, B and C) are introduced	

Figure 34. The Crew management KPI (Source: Marintek)

KPI: Crew planning	
The ship management organisation's performance in crew planning. Measured per calendar year. Measured as a vessel KPI for internal improvement as well as external communication (input to SPIs)	
Relevant PIs: •No of crew not relieved on time •Violation of rest hours	
KPI Value Formula=	No of crew not relieved on time + Violation of rest hours
KPI Rating Formula=	100-(Z*KPI Value)
Rating Parameters:	Z= 10
This KPI count the ship manager's ability to relieve crew on time as well as avoiding violations of rest hours.	

Figure 35. The Crew planning KPI (Source: Marintek)

KPI: Port state control detention	
The number of Port State Control Inspections resulting in a detention in a calendar year. Measured per vessel for internal improvement as well as external communication (input to SPIs)	
Relevant PIs: •Total number of PSC inspections resulting in a detention	
KPI Value Formula=	Total Number of PSC inspections resulting in a detention
KPI Rating Formula=	100 if KPI Value = 0 0 if KPI Value > 0
Rating Parameters:	N/A
This KPI is one of three KPIs related to Port State Control Inspections. The three areas covered are; 'Flawless port state control performance' which measures the percentage of port state controls resulting in zero deficiencies, 'Port state control deficiency rate' which measures the ratio of the total number of issued deficiencies during port state control inspection against the total number of port state control inspections conducted and this specific KPI, 'Port state control detention' which measures the total number of port state control inspections resulting in a detention. No denominator is used in this KPI	

Figure 36. The Port state control detention KPI (Source: Marintek)

KPI: Flawless Port state control performance

The ratio of port state control inspections resulting in zero deficiencies in a calendar year compared to the total number of PSC inspections. Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
- PSC inspections resulting in zero deficiencies
- Total number of PSC inspections

KPI Value Formula= $\frac{\text{PSC inspections resulting in zero deficiencies}}{\text{Total number of PSC inspections}}$

KPI Rating Formula= Z*KPI Value

Rating Parameters: Z= 100

This KPI is one of three KPIs related to Port State Control Inspections. The three areas covered are; 'Port state control deficiency rate' which measures the ratio of the total number of issued deficiencies during port state control inspection against the total number of port state control inspections conducted, 'Port state control detention' which measures the total number of port state control inspections resulting in a detention and this specific KPI, 'Flawless port state control performance' which measures the percentage of port state controls resulting in zero deficiencies against the total number of port state control inspections conducted

Figure 37: The Flawless port state control performance KPI (Source: Marintek)

KPI: Crew behaviour

The behaviour of the crew on a vessel. Counted per calendar year and made relative to the average number of crew onboard the vessel in a calendar year. If one incident of the same crew breach several categories, each breach should be counted individually.
Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
- A: Absconded Crew
- B: Criminal offence
- C: Drugs or alcohol abused
- D: No of dismissed crew
- E: No of logged warnings
- F: Total Exposure hours

KPI Value Formula= $\frac{(A+B+C+D+E)*(24*365)}{F}$

KPI Rating Formula= 100-(Z*KPI Value)

Rating Parameters: Z= 1000

This KPI counts the total number of breaches of code of conduct made by the vessel's crew such as substance abuse, criminal offences and AWOLs.
As the number of crew on different vessels vary significantly, total exposure hours (divided by 24*365 to represent the average number of crew onboard the vessel) is used as a denominator to enable benchmarking

Figure 38: The Crew behaviour KPI (Source: Marintek)

Appendix II. Cargo safety in the Shipping KPI project

According to Marintek (2008), the Shipping KPI project expresses the cargo safety performance of a ship through a Shipping Performance Index (SPI, indices of higher level of hierarchy than KPIs) named “Safety Performance”. The index combines the results of safety incidents with relevant prevention measures.

As shown in Figure 39 below, this is a composite index depending on 12 different KPIs [41]. The crew- and port state control-related aspects of the index are identical to those of Security Performance SPI, presented in Appendix I. Furthermore, the safety index depends on fire and explosion, navigational, equipment failure, and cargo incidents, in addition to fatalities, injuries, lost workdays and safety deficiencies recorded during external inspections of the ship.

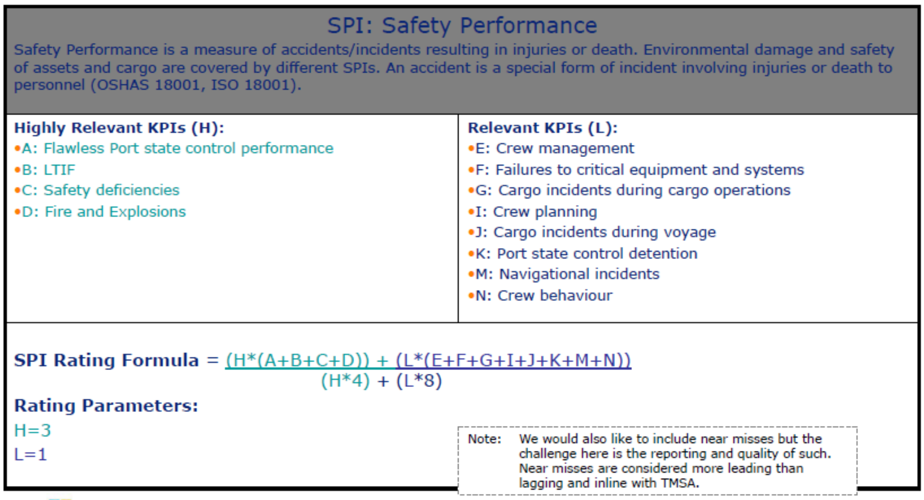

Figure 39. The Safety Performance SPI (Source: Marintek)

The 7 new KPIs entering the Safety Performance SPI are defined below:

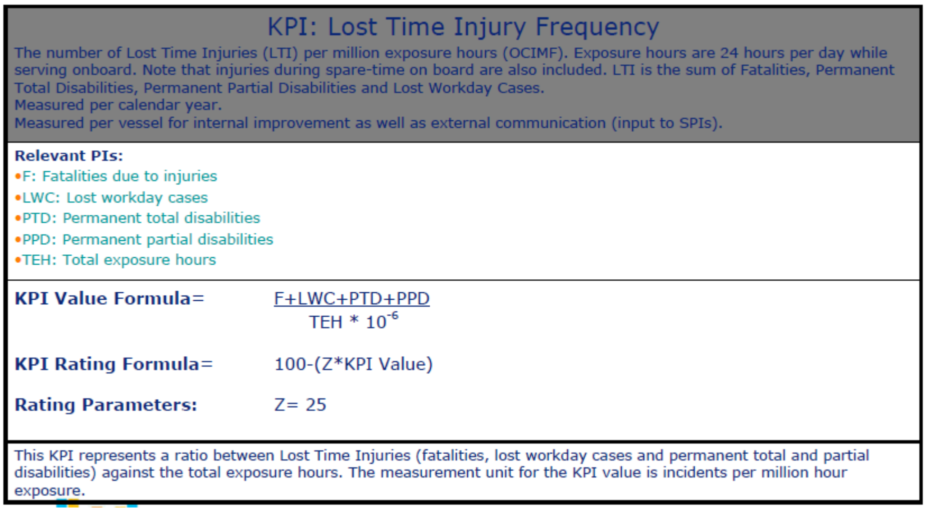

Figure 40. The Lost time injury frequency KPI (Source: Marintek)

[41] The website of the Shipping KPI project presents a revised formula for the Security Performance SPI.

KPI: Safety deficiencies

Safety related deficiencies, observations and non-conformances, recorded during external inspections and audits in a calendar year. Made relative to the total number of external inspections in a calendar year.
Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
- Total number of Safety related deficiencies
- Total number of recorded external inspections

KPI Value Formula= $$\frac{\text{Total number of Safety related deficiencies}}{\text{Total number of recorded external inspections}}$$

KPI Rating Formula= 100-(Z*KPI Value)

Rating Parameters: Z= 33,33

This KPI is part of a range of KPIs related to deficiencies that are identified during external inspections. These deficiencies are categorized depending on their nature. An example of a safety deficiency can be misplaced life buoys or fire hoses.

The total number of recorded external inspection is used as a denominator in all these KPIs in order to enable benchmarking between vessels that are subject to a uneven number of external inspection.

Figure 41. The Safety deficiencies KPI (Source: Marintek)

KPI: Fire and Explosions

The total number of fire and explosions incidents in a calendar year. Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
- Total number of fire incidents
- Total number of explosion incidents

KPI Value Formula= Total number of fire incidents + Total number of explosion incidents

KPI Rating Formula=
0 = 100 rating
1 = 50 rating
> 1 = 0 rating

Rating Parameters: N/A

This KPI counts the total number of incidents related to fire and explosions

Figure 42. The Fire and explosions KPI (Source: Marintek)

KPI: Failure of critical equipment and systems

The total number of failures to equipment and systems in the critical list (as required by the ISM code 10.3 and defined in the company Safety Management System) resulting in whole or partial unavailability in a calendar year.
Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
- Failure of critical equipment and systems

KPI Value Formula= ΣFailure of critical equipment and systems

KPI Rating Formula= 100-(Z*KPI Value)

Rating Parameters: Z= 20

As the vessels' critical lists may vary in size it could be argued that e.g. the number of items on the list could be used as a denominator for benchmarking purposes. In any case, a failure to a critical equipment or system is a serious matter, regardless of the number of items in the vessel's critical list, and the KPI 'Failure to critical equipment and systems is kept without a denominator

Figure 43. The Failure of critical equipment and systems KPI

KPI: Cargo incidents during cargo operations

The total number of received claims concerning damaged or lost cargo or injured passengers during cargo operations in a calendar year. Made relative to the total number of cargo units transported in a calendar year. Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
- Total number of damaged or lost cargo units or passengers injured during cargo handling
- Total number of cargo units or passengers transported

KPI Value Formula=

$$\frac{\text{Total number of damaged or lost cargo units or passengers injured during cargo handling}}{\text{Total number of cargo units or passengers transported}}$$

KPI Rating Formula= 100-(Z*KPI Value)

Rating Parameters: Z= 100000

This KPI represents a ratio between the total quantity of damaged or lost cargo or injured passengers (during handling operations such as loading cargo or boarding passengers) relative to the total quantity of cargo or number of passengers handled in a calendar year. By defining the KPI as a ratio, benchmarking is feasible even between different vessel sizes.

Figure 44. The Cargo incidents during cargo operations KPI

KPI: Cargo incidents during voyage

The total number of received claims concerning damaged or lost cargo or injured passengers during voyage in a calendar year. Made relative to the total number of cargo units transported in a calendar year. Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
- Total number of damaged or lost cargo units or passengers injured during voyage
- Total number of cargo units or passengers transported

KPI Value Formula=

$$\frac{\text{Total number of damaged or lost cargo units or passengers injured during voyage}}{\text{Total number of cargo units or passengers transported}}$$

KPI Rating Formula= 100-(Z*KPI Value)

Rating Parameters: Z= 1000000

This KPI represents a ratio between the total quantity of damaged or lost cargo or injured passengers (during the actual sea voyage) relative to the total quantity of cargo or number of passengers transported in a calendar year. By defining the KPI as a ratio, benchmarking is feasible even between different vessel sizes.

Figure 45. The Cargo incidents during voyage KPI

KPI: Navigational incidents

Any navigational incident resulting in a collision, allision or grounding in a calendar year. All incidents are counted regardless of the cause of the incident.
Measured per vessel for internal improvement as well as external communication (input to SPIs)

Relevant PIs:
- Collision
- Allision
- Grounding

KPI Value Formula= (A*Collision) + (B*Allision) + (C*Grounding)

Value Parameters: A= 2
B= 1
C= 2

KPI Rating Formula= 100-(Z*KPI Value)

Rating Parameters: Z= 50

This KPI measures the total number of collisions, allisions and groundings recorded in a calendar year.

The KPI's value is a simple counter where the parameters weight collision and grounding twice as influential to the KPI as an allision

Figure 46. The Navigational incidents KPI (Source: Marintek)

An alternative way of combining together different issues that affect cargo safety can be seen at the following formula (Mittal, 2008):

$$\text{Example KPI} = \frac{SC + ST + SI + ISPS}{PC}$$

where:

SC: Sum of smuggling cases by crew per calendar year (number of incidents per year)

ST: Sum of smuggling cases by 3rd party per calendar year (number of incidents per year)

SI: Stowaway incidents per calendar year (number of incidents per year)

ISPS: ISPS violations per calendar year (number of violations per year)

PC: Port calls (number of port calls per year)

Appendix III. Congestion

1. Approaches in literature

When trying to measure congestion from a practical standpoint, different approaches are classed as follows:

- travel time (or speed) based measures
- traffic volume based measures
- area based measures

Examples of KPIs are the following:

- 'Total delay' to 'volume of traffic' ratio: Gives the "average amount of delay" for a vehicle travelling one kilometer.
- Speed-based KPIs which are esp. relevant for motorways (e.g., a congested state exists when the traffic speed is below 70 kph).
- The congestion reference flow (for more information see below).
- The level of service (for more information see below).

The "congestion reference flow" is an index based on the capacity of the road, the number of lanes and other traffic related variables. The CRF of a link is given by the formula (excerpt from highways.gov.uk):

CRF = CAPACITY * NL * Wf * 100/PkF * 100/PkD *AADT/AAWT

where

CAPACITY is the maximum hourly lane throughput:

CAPACITY = [A-B*Pk%H]

Pk%H is the percentage of HGVs in the peak hour

A and B are fixed parameters dependent on road standard; for Motorways these are: A = 2300 and B = 25.0;

NL is the number of lanes;

Wf is a width factor;

PkF is the proportion (percentage) of the total daily flow (2-way) that occurs in the peak hour;

PkD is the directional split (percentage) of the peak hour flow;

AADT is the Annual Average Daily Traffic flow on the link;

AAWT is the Annual Average Weekday Traffic flow on the link.

The 'level of service' indicator is a basic congestion scale running from A to F (with A being best and F being worst) and describes conditions using variables such as speed, travel time, disruption to flows and safety. It is widely used in the USA. The Highway Capacity Manual and AASHTO Geometric Design of Highways and Streets ("Green Book") list the following levels of service:

A Free flow

B Reasonably free flow

C Stable flow

D Approaching unstable flow

E Unstable flow

F Forced or breakdown flow

These levels of service are defined in the following table:

Table 10. Congestion scale (Source: VTPI, 2010)

LOS	Description	Speed (mph)	Flow (veh./hour/lane)	Density (veh./mile)
A	Traffic flows at or above posted speed limit. Motorists have complete mobility between lanes.	Over 60	Under 700	Under 12
B	Slightly congested, with some impingement of maneuverability. Two motorists might be forced to drive side by side, limiting lane changes.	57-60	700-1,100	12-20
C	Ability to pass or change lanes is not assured. Most experienced drivers are comfortable and posted speed maintained but roads are close to capacity. This is the target LOS for most urban highways.	54-57	1,100-1,550	20-30
D	Speeds are somewhat reduced, motorists are hemmed in by other vehicles. Typical urban peak-period highway conditions.	46-54	1,550-1,850	30-42
E	Flow becomes irregular, speed vary and rarely reach the posted limit. This is considered a system failure.	30-46	1,850-2,000	42-67
F	Flow is forced, with frequent drops in speed to nearly zero mph. Travel time is unpredictable.	Under 30	Unstable	67-Maximum

The following table summarizes units commonly used to measure traffic:

Table 11. Units for the measuring of traffic (Source: VTPI, 2010)

Parameter	Typical Units	Reciprocal	Typical Units
Flow	Vehicles per hour (Veh/h)	Headway	Seconds per vehicle (s/veh)
Speed	Kilometers per hour (Km/h)	Travel time	Seconds per km (s/km)
Density	Vehicles per lane-km (veh/lane-km)	Spacing	Meters per vehicle (m/veh)

2. Congestion-related costs

Time losses for individuals and businesses amount to many billions of dollars, equivalent in the more congested countries to ca. 1% of GDP (CEMT/ITF, 2007).

As follows, we provide several tables containing data on congestion, always referring to their sources. These references are publicly available so the interested reader can refer to the original sources.

Table 12. Congestion cost summary (Source: VTPI, 2010)

Publication	Costs	Cost Value	2007 USD
Delucchi (1997)	Total US in 1991	$34-146 billion (1991)	$52-222 billion
	Per urban peak mile	$0.07-0.32	$0.11-0.49/mile
Lee (2006)	U.S. traffic congestion delay costs, relative to free flowing traffic	$108 billion (2002)	$124 billion
	Delay costs based on willingness to pay	$12 billion	$14 billion
TRB (1994)	Congested urban roads per vehicle mile	average of $0.10 to 0.15*	$0.14-0.21/mile
Texas Transportation Institute (2007)	Total USA in 2005	$78.2 billion (2005)	$83 billion
Winston and Langer (2004)	Total US congestion costs	$37.5 billion (2004)	$41 billion
Land Transport New Zealand (2005).	Benefits of TDM mode shift per Km	$1.27 - Auckland, $0.98 - Wellington, $0.09 - Cristchurch (NZ$ 2002 / Km.)	$1.09 / mile $0.84 $0.08
FHWA (1997)	Urban Highway Car	$0.062 / VMT*	$0.08 / mile
	Bus	$0.128	$0.17
M. Maibach, et al (2008)	Urban collectors in European centres over 2 million - Car	0.5 €/vkm 2000	$0.89 / mile
	Truck	1.25 €	$2.23

Table 13. Marginal external congestion costs in Australia (Australian cents per vehicle kilometre) [Source: VTPI, 2010]

	Melbourne	Sydney	Brisbane	Adelaide	Perth
Freeways	14¢	13¢	14¢	0	14¢
CBD Streets	57¢	62¢	40¢	40¢	40¢
Inner Arterials	20¢	21¢	16¢	16¢	16¢
Outer Arterials	7¢	7¢	5¢	5¢	5¢

Table 14. Estimated highway congestion costs (USD Cents per Vehicle Mile) [Source: VTPI, 2010]

	Rural Highways			Urban Highways			All Highways		
	High	Med.	Low	High	Med.	Low	High	Med.	Low
Automobile	3.76	1.28	0.34	18.27	6.21	1.64	13.17	4.48	1.19
Pickup & Van	3.80	1.29	0.34	17.78	6.04	1.60	11.75	4.00	1.06
Buses	6.96	2.37	0.63	37.59	12.78	3.38	24.79	8.43	2.23
Single Unit Trucks	7.43	2.53	0.67	42.65	14.50	3.84	26.81	9.11	2.41
Combination Trucks	10.87	3.70	0.98	49.34	16.78	4.44	25.81	8.78	2.32
All Vehicles	4.40	1.50	0.40	19.72	6.71	1.78	13.81	4.70	1.24

Table 15. Marginal social costs of congestion by road class (2000 €/vehicle km) [Source: VTPI, 2010]

Area & Road Type	Passenger Cars	Goods Vehicles
Large urban areas (> 2,000,000)		
Urban motorways	0.50	1.75
Urban collectors	0.50	1.25
Local streets centre	2.00	4.00
Local streets cordon	0.75	1.50
Small and medium urban areas (< 2,000,000)		
Urban motorways	0.25	0.88
Urban collectors	0.30	0.75
Local streets cordon	0.30	0.60

Table 16. Congestion costs (2007 US$/vehicle mile) [Source: VTPI, 2010]

Vehicle Class	Urban Peak	Urban Off-Peak	Rural	Average
Average Car	0.130	0.020	0.000	0.035
Compact Car	0.130	0.020	0.000	0.035
Electric Car	0.130	0.020	0.000	0.035
Van/Light Truck	0.130	0.020	0.000	0.035
Rideshare Passenger	0.000	0.000	0.000	0.000
Diesel Bus	0.270	0.040	0.000	0.069
Electric Bus/Trolley	0.270	0.040	0.000	0.069
Motorcycle	0.130	0.020	0.000	0.035
Bicycle	0.010	0.001	0.000	0.002
Walk	0.003	0.001	0.000	0.001
Telework	0.000	0.000	0.000	0.000

The VTPI (2010) study concludes with this important table:

Table 17. Estimation of congestion costs (2007 US$/vehicle mile)

Vehicle Class	Urban Peak	Urban Off-Peak	Rural	Average
Average Car	0.130	0.020	0.000	0.035
Compact Car	0.130	0.020	0.000	0.035
Electric Car	0.130	0.020	0.000	0.035
Van/Light Truck	0.130	0.020	0.000	0.035
Rideshare Passenger	0.000	0.000	0.000	0.000
Diesel Bus	0.270	0.040	0.000	0.069
Electric Bus/Trolley	0.270	0.040	0.000	0.069
Motorcycle	0.130	0.020	0.000	0.035
Bicycle	0.010	0.001	0.000	0.002
Walk	0.003	0.001	0.000	0.001
Telework	0.000	0.000	0.000	0.000

In another study, Lindberg (2003) summarizes certain issues related to congestion costs with an emphasis on Sweden. However, he acknowledges that "The main problem in estimating the congestion cost is to anticipate the reaction of the users; while it is relatively simple to estimate the external congestion cost at the current traffic load the cost at the optimal traffic load, that will be the result of a road pricing scheme, is much more difficult to assess."

So, in many of the tables contained in Lindberg (2003), like the following one, it is not clarified what part of external costs is attributed to congestion.

Table 18. External cost of trucks, Sweden (€/vehicle km) [Source: Lindberg, 2003]

		Wear and tear[1]	*trailer*	*Emissions*[2]	*Noise*[3]	*Accidents*	*Global Warm*	***TOTAL***
Urban	3.5-16t	0,01	0,01	0,12	0,06	0,07	0,04	**0,30**
	>16t	0,02	0,03	0,18	0,31	0,07	0,10	**0,70**
Rural	3.5 - 16t	0,01	0,01	0,04	0,01	0,04	0,05	**0,14**
	>16t	0,02	0,03	0,08	0,03	0,04	0,09	**0,28**

Source: SIKA 2003:6

Moreover, the interested reader is referred to Akyelken (2010) who discusses the policy implications of external costs of congestion.

Maritime-related congestion (esp. at ports) should not be overlooked. Delays at ports are especially prevalent in busy container and dry bulk terminals. At certain instances, the congestion can be so high that a significant part of the total of ocean-going vessels of a specific type is queued. In this case, congestion plays a factor in determining spot freight rates (for example, this has happened recently at the Capesize market, since many Capesize vessels were queued at Australian ports).

Appendix IV. Traffic Safety

1. Safety in rail transport

Accident definition (Eurostat regulations)
'Significant accident' means any accident involving at least one rail vehicle in motion, resulting in at least one killed or seriously injured person, or in significant damage to stock, track, other installations or environment, or extensive disruptions to traffic. Accidents in workshops, warehouses and depots are excluded.

ERA (European Railway Agency)
ERA produces a biennial report on the development of railway safety in EU; the next report is due in 2010. (http://www.era.europa.eu/Document-Register/Pages/Railway-Safety-Performance-in-the-European-Union-2009.aspx)

There are currently two separate EU pieces of legislation in place requiring Member States to report rail accident data; they are Regulation (EC) N° 91/2003 for reporting data to Eurostat and the Safety Directive 2004/49/EC for reporting data to the Agency. The reports build upon both Eurostat data and the common safety indicators as reported directly to the Agency. The Interim report in 2009 contains information on the common safety indicators as well as information on safety certification, safety regulation and accident investigations carried out.

ERA has developed a set of common safety indicators (CSIs) used in these reports. CSIs are a set of rail safety data, gathered to facilitate the assessment of achievement of Common Safety Targets (CSTs) and monitor the development of safety in Member States. CSIs are based on common definitions and calculation methods. (http://www.era.europa.eu/Core-Activities/Safety/Pages/common-safety-indicators.aspx).

The data set is structured into:

- Significant accidents
- Deaths and serious injuries
- Suicides
- Precursors of accidents
- Economic impact of accidents
- Technical aspects (collisions of trains, level crossings by type, derailment and automatic train protection systems)
- Management of safety

According to the latest report fatal accidents occur mainly to unauthorized persons and level crossing users. The total number of suicide outweighs the total number of fatalities in all types of accidents.

2. Safety in Road Transport

Accident definition from Eurostat Transport Statistics
(http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/introduction)

Any accident involving at least one road vehicle in motion on a public road or private road to which the public has right of access, resulting in at least one injured or killed person. A suicide or an attempted suicide is not an accident but an incident caused by a deliberate act to injure oneself fatally. However, if a suicide or an attempted suicide causes injury to another road user, then the incident is regarded as an injury accident. Included are: collisions between road vehicles; between road vehicles and pedestrians; between road vehicles and animals or fixed obstacles and with one road vehicle alone. Included are collisions between road and rail vehicles. Multi-vehicle collisions are counted as only one accident provided that any successive collisions happen within a very short time period. Injury accidents exclude accidents incurring only material damage. Excluded are terrorist acts. Fatal accident: Any injury accident resulting in a person killed. Non-fatal accident: Any injury accident other than a fatal accident.

Yearly statistical pocketbook published by EU
(http://ec.europa.eu/transport/publications/statistics/statistics_en.htm)

Describes the following indicators on safety:

- Road Fatalities by Year
- Road Fatalities Country Rankings
- Road Fatalities by Type of User
- Road Fatalities of Vehicle Occupants by Type of Vehicle
- Road Accidents: Number of accidents involving personal injury
- Railway Fatalities: Number of railway passengers killed in accidents involving railways
- Sea: Ships Lost (World)

SafetyNet
(http://erso.swov.nl/safetynet/content/safetynet.htm)

SafetyNet was an Integrated Project funded by DG-TREN of the European Commission. The objective of the project was to build the framework of a European Road Safety Observatory, which will be the primary focus for road safety data and knowledge, as specified in the Road Safety Action Plan 2003. The Observatory will support all aspects of road and vehicle safety policy development at European and national levels.

SafetyNet has made new proposals for common European approaches in several areas including exposure data and Safety Performance Indicators. It has extended the CARE database to incorporate the new EU Member States and has developed new fatal and in-depth accident causation databases. It has also developed new statistical methods that can be used to analyse combined macroscopic and other data.

Other data sources
ERSO (European Road Safety Observatory) Page with an overview of projects and links: http://erso.swov.nl/safetynet/content/safetynet.htm

CARE (http://ec.europa.eu/transport/road_safety/observatory/statistics/care_en.htm) is a database on road accidents resulting in death or injury collected by the Member States.

European Transport Safety Council (http://www.etsc.eu/home.php) provides statistics on road safety.

3. Safety in Maritime transport

Definitons by Shipping KPI
(http://www.sintef.no/Projectweb/Shipping-KPI/Testside/Shipping-Performance-Indices/Safety-Performance/)

Shipping KPi has identified a SPI (Shipping performance index) related to safety performance (see also Appendix II). This is made of several KPI's of which three are relevant for the SuperGreen project:

- Fire and Explosions: Expresses the company's ability to avoid fire and explosions onboard the vessel. The KPI counts the number of fire and explosion incidents.
- Lost Time Injury Frequency: Expresses the company's ability to safeguard crew against injuries and fatalities. The KPI counts the number of Lost Time Injuries (LTI) among the crew per million exposure hours. Exposure hours are 24 hours per day while serving onboard. Note that injuries during spare-time on board are also included. LTI is the sum of Fatalities, Permanent Total Disabilities, Permanent Partial Disabilities and Lost Workday Cases. The term 'crew' refers to any person being part of the vessel's complement (e.g. officers, ratings, cadets, superintendents). The same complement is also used as basis for calculating the Total Exposure Hours.
- Safety deficiencies: Expresses the company's ability to avoid safety related deficiencies recorded during external inspections and audits. The KPI counts the number of safety related deficiencies including any sub-standard act, practice or condition (such as misplaced life buoys or fire hoses) recorded during external inspections and audits. The number of deficiencies is then made relative to the total number of external inspections.

The challenges with these indicators are that they are not tied directly to an easily accessible database, so the usability to the SuperGreen project is limited.

European Maritime Safety Agency
(http://www.emsa.europa.eu/)

Has developed a ship risk calculator

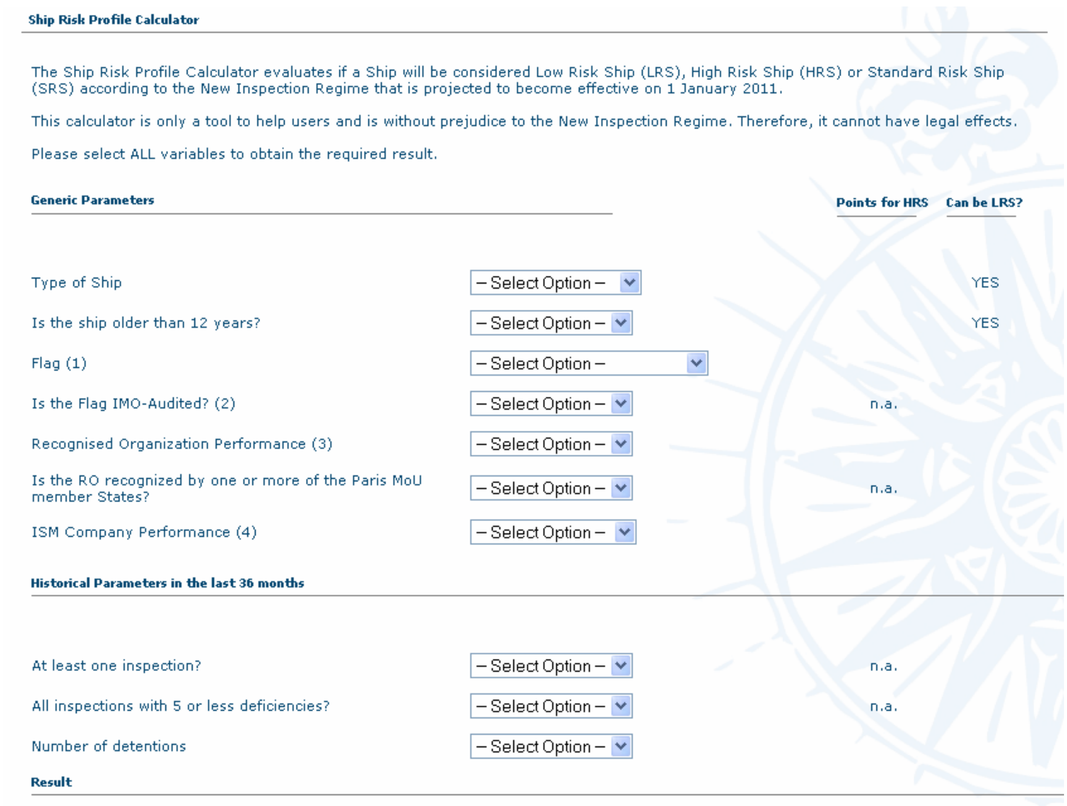

Figure 47. EMSA's Risk calculator (Source: EMSA)

(http://www.parismou.org/ParisMOU/New+Inspection+Regime/Ship+risk+profile+calculator/default.aspx)

EQUASIS

EQUASIS is an information system collating existing safety-related information on ships from both public and private sources available on the Internet developed by the European Commission and the French Maritime Administration. Requires that users are registered in their database. (http://www.equasis.org/EquasisWeb/public/HomePage?fs=HomePage).

Appendix V. Noise

1. Introduction and definition of noise

All citizens are at some point affected by noise, which can have a considerable impact on people's quality of life. As stated in WHO's Guidelines for Community Noise (Berglund et al 1999, p. iii), about half of the EU citizens (EU 15) are estimated to live in areas which do not ensure acoustical comfort for residents: 40% of the population is exposed to road traffic noise with an equivalent sound pressure level exceeding 55 dB(A) during daytime, and 20% to levels exceeding 65 dB(A). At night, more than 30% are exposed to sound levels that disturb sleep (exceeding 55 dB(A). Even though the question of causality between exposure to noise and health risks has not yet been answered, existing studies show that noise exposure increases the risk for high blood pressure and heart attacks. There is evidence that noise pressure levels exceeding 50 db(A) during night time are related to the development of high blood pressure. Road traffic noise exceeding 65 db(A) during day time increases the risk for heart attacks in men with 20% (Babisch, 2004: p. 51). (SILENCE, 2008).

Noise pollution is commonly defined as:

noise pollution = the excessive or annoying degree of unwanted sound in a particular area

The main document providing direction for R&D within this field is the "Environmental Noise Directive 2002/49/EC" distributed by the European Commission. The major goal of the Directive is to achieve a high level of protection for communities and the environment through mapping, dissemination of information, and the adoption of action plans. The Directive requires Member States to:

- Draw-up strategic noise maps for major agglomerations using harmonized noise indicators Lden (day-evening-night equivalent level) and Lnight (night equivalent level). While the Directive addresses specifically the noise from industrial activity sites located in the port areas, the issue of industrial noise has not received as much attention as the noise from transport (aviation, road, rail).
- Inform and consult the public about noise exposure, its effects, and the measures considered to address noise.
- Draw up action plans to reduce noise where necessary and maintain environmental noise quality where it is good.

The "Environmental Noise Directive" (END), relating to the assessment and management of environmental noise was adopted by the European Parliament and Council in 2002. This Directive will guide and steer activities on noise in member States and large conurbations in the coming years. The directive describes environmental noise as "unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport, road traffic, rail traffic, air traffic, and from sites of industrial activity" (Directive 2002/49/EC, article 3). Ambient or environmental noise covers long-term noise from transport and industry sources, as distinct from noise caused by neighbours, construction sites, pubs, etc. Main aim of the Directive is to provide a common basis for tackling the noise problem across the EU (SILENCE, 2008).

From the above, and although ports not being mentioned specifically, the port's role as a critical transport node in any integrated transport chain means that the END is of direct relevance.

2. Noise as a KPI

Noise is typically measured in decibel (dB) and noise indicators are typically an average of volume and duration over a fixed period of time. Because noise level changes all the time, averaging is termed equivalent noise level (Leq). LAeq refers to the energy equivalent average sound pressure level measured using the A-weighting which is most sensitive to speech intelligibility frequencies of the human ear. As the same noise is judged differently between day time and night time, the EU proposed the following time periods for calculations:

- Lday is the A-weighted long-term average sound level 07:00-19:00 (12 hours)
- Levening is the A-weighted long-term average sound level 19:00-23:00 (4 hours)
- Lnight is the A-weighted long-term average sound level 23:00-07:00 (8 hours)

The overall day-evening-night noise level is expressed by the Lden indicator. Lden is a descriptor of noise level based on energy equivalent noise level (Leq) over a whole 24 hour day with a penalty of 10 dB(A) for night time noise (23.00-7.00) and an additional penalty of 5 dB(A) for evening noise (19.00-23.00).

Figure 48. Typical noise levels experienced by the public from "Good Practice Guide on Port Area Noise Mapping and Management"

(http://nomeports.ecoports.com/page.ocl?pageid=6&mode=&version=&nid=17)

Although noise limits have become increasingly stringent over the years, no corresponding significant reduction in noise levels in urban areas has been observed (SILENCE, 2008).

The below mentioned projects visualize a move towards reducing the environmental impact of noise pollution.

- SILENCE
- Q-CITY
- BESTUFS II
- SMILE guidance
- GOAL

3. Ports and noise mapping measures

3.1 The NoMEPorts Project[42]

In order to comply with the END objectives, the port sector has pursued its established concept where research and development is required to produce practicable methodologies for port-based implementation of new legislation by initiating a collaborative project. Managed by the EcoPorts Foundation, the project NoMEPorts has as its main objective the reduction of noise, noise-related annoyance and health problems of people living around port industrial areas through demonstrations of a noise mapping and management system. The project is funded by the LIFE-Environmental Programme of the European Commission.

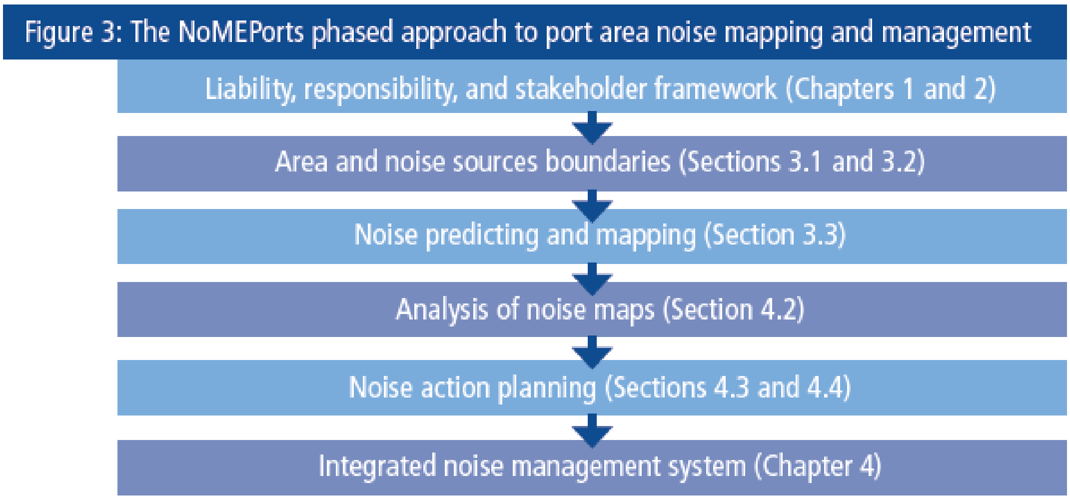

Figure 49. NoMEPorts steps for noise mapping and management (Source: NoMEPorts, 2008)

NoMEPorts draws on noise calculation methods developed in previous EU Projects HARMONOISE and IMAGINE to produce a new EU methodology, evaluated and validated in the partner ports. Fundamental to the project is the imperative to take a generic, harmonized approach to data collection and to produce a set of guidelines or response options to the challenges of noise management that are transferable to the wider port community. This latter point is the essence of the EPF approach where ports help ports for the mutual benefits of demonstrating compliance with legislation, and the reduction of costs and risks through the application of practicable tools and methodologies. Port noise maps (2-D and 3-D) are set to become increasingly valuable resources for effective, environmental management decision making in the complex that is the port-city area. EPF and NoMEPorts partners are currently evaluating methodologies and developing guidelines for consideration by the Commission – and transfer of experience throughout the port sector.

[42] *Partner ports are*: Amsterdam (Project Leader), Civitaveccia, Copenhagen/Malmo, Hamburg, Livorno, and Valencia. *Observer ports are* Bremen, Gothenburg, Oslo, Rotterdam and Tenerife. The partners are assisted by EPF (project management and dissemination, GMR, NL (noise specialists), and Cardiff University, UK (science co-ordination).

NoMEPorts has published a "Good Practice Guide on Port Area Noise Mapping and Management" It is a tool to analyse the noise situation and thus form the basis for developing action plans on how to reduce/minimize the impact of noise. The Guide has been prepared for senior port managers, port environmental managers, policy-makers, environmental authorities, spatial planners and strategic decision-makers. (http://nomeports.ecoports.com/page.ocl?pageid=6&mode=&version=&nid=17)

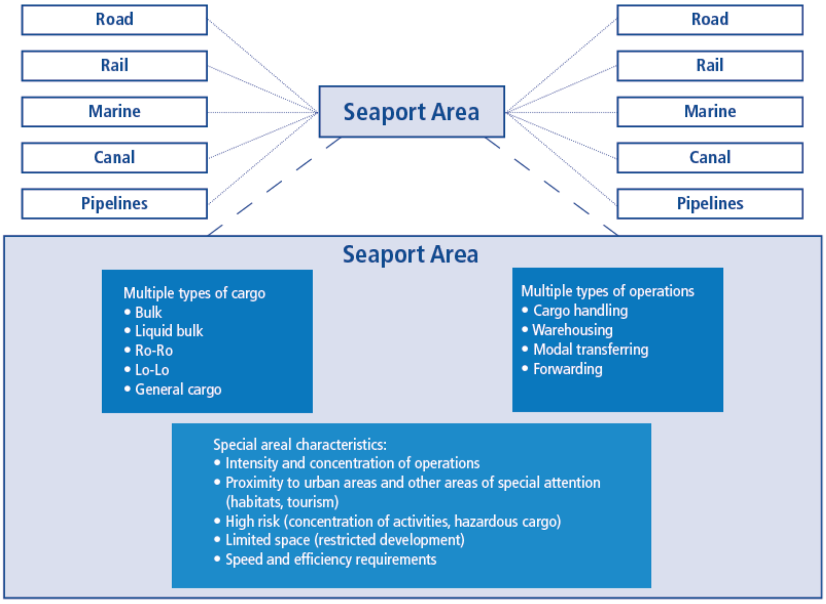

Figure 50. Port area characteristics (Source: NoMEPorts Project)

Most ports produce maps of noise in their area, this can be found at homepages available to the public.

3.2 Noise mapping

The strategy put forward by the European Directive on Environmental noise is that the first step towards controlling ambient noise consists of collecting detailed information on the number of residents exposed to various noise levels and providing these data in the form of noise maps.

The Noise Directive describes noise mapping as "the presentation of data on an existing or predicted noise situation in terms of a noise indicator, indicating breaches of any relevant limit value in force, the number of people affected in a certain area, or the number of dwellings exposed to certain values of a noise indicator in a certain area" (Directive 2002/49/CE, p.3). A noise map allows to visually present data related to the following aspects:

- the noise environment according to certain noise indicators;
- the exceeding of limit values;
- the estimation of the number of dwellings, schools and hospitals in certain areas that are exposed to certain noise levels;
- the estimated number of people exposed to certain noise levels in an area.

3.3 Noise management

It includes the following activities:

- Analyse noise map
- Identify noise 'hot-spots' and high priority areas
- Mitigating measures

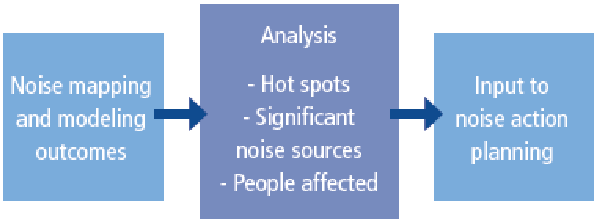

Figure 51. Noise management process

3.4 Noise mapping and assessments in Europe (coordinated by Eionet)

The main aim of this project is the development of a geospatial database of the noise data provided by the Member States in compliance with the Environmental Noise Directive (END), reporting obligations. The development of several tasks in parallel facilitates the accomplishment of the main objective of this project:

- Improvement of the tool to report the data (by using the Central Data Repository of Reportnet)
- Quality check of the noise data being provided by the Member States
- Establishment of the Noise Reference Layer, which contain the urban areas and main transport networks where the END is applicable.
- Built up a tabular database containing noise exposure data and link it with the Noise Reference Layer.

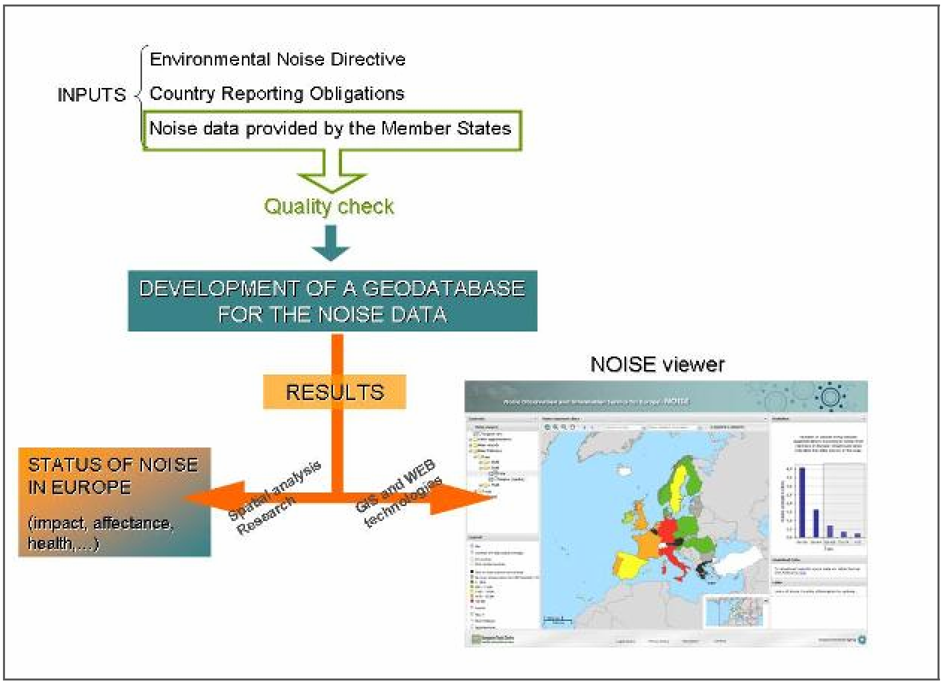

Figure 52. Noise database input and output (Source: Eionet)

The Eionet tool to measure noise at roads, railway and airport can be found at: http://noise.eionet.europa.eu/

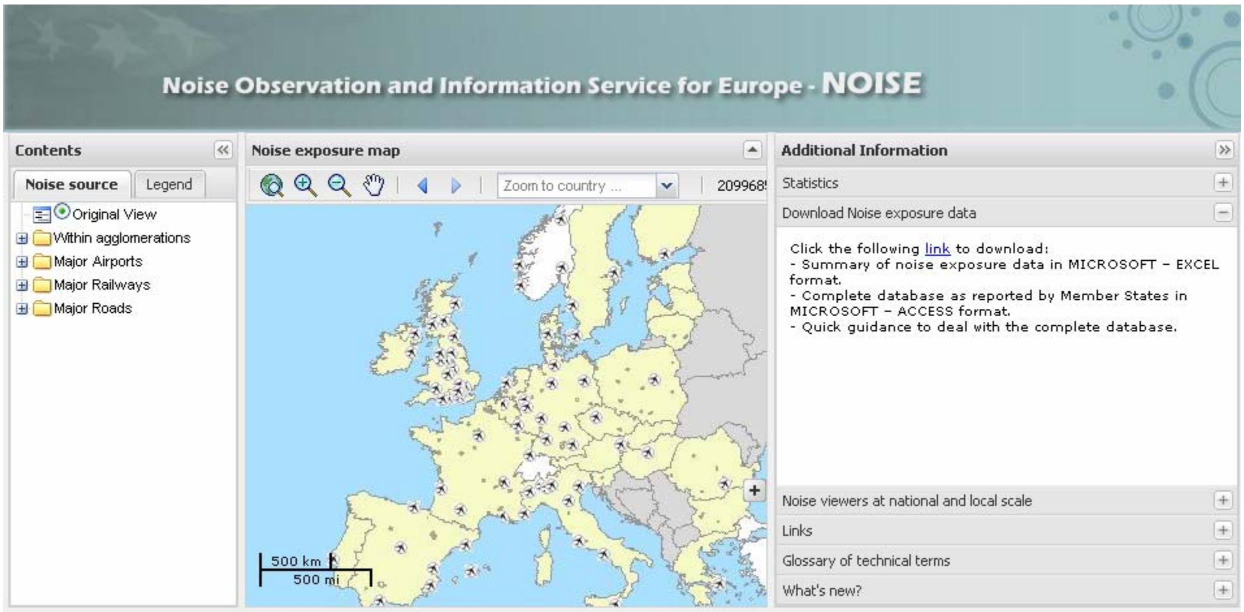

Figure 53. Eionet database for producing noise maps from EU members

3.5 Sources

Good Practice Guide on Port Area Noise Mapping and Management – NoME Ports project

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http://noise.eionet.europa.eu/