MINT – model and decision support systems for intermodal terminal networks

Introduction

Editor: Bo Östlund

IMPRINT

Date

27-09- 2011

Basic Material and Documents

Deliverable 1 – MINT State-of-the-art
Main authors: Fredrik Bärthel, Bo Östlund and Jonas Flodén.

Deliverable 2 Framework for strategic integrated terminal network evaluation
Main author: Jonas Flodén.

Deliverable.3 Modelling and simulation of intermodal terminal networks
Main authors: Edith Schindlbacher, Hans Häuslmayer, Manfred Gronalt.

Deliverable 4 – Deepening Network Analysis
Main authors: Martin Ruesch, Bo Östlund, Simone Jegerlehner

Deliverable 5 – MINT Case studies
Main authors: Martin Ruesch, Fredrik Bärthel, Jonas Flodén and Thoraya Rojas-Navas.

ERA NET Framework

This report forms a deliverable in the ERA NET ENT16 "Intermodal freight transport".

MINT Partners

TFK – Transport Research Institute Borlänge, Sweden (http://www.tfk.se) – Coordinator
h2 projekt.beratung KG, Vienna, Austria, (http://www.h2pro.at)
Rapp Trans Ltd, Zürich, Switzerland (http://www.rapp.ch)
Royal Institute of Technology, Stockholm, Sweden, (http://www.infra.kth.se)
School of Business, Economics and Law, University of Gothenburg, Sweden (http://www.hgu.gu.se)
University of Natural Resources and Life Sciences Vienna, Austria (http://www.boku.ac.at)

Editor of the Report

Bo Östlund, bo@tfk.se, ostlunds@bahnhof.se

Photos on front page: Fredrik Bärthel, School of Business, Economics and Law, Göteborg (all pictures except the upper right) and Christian Krüger and Johannes Gregor, BoxXpress (upper right).

Preface

This report is an introduction to the ERA NET ENT16 project *MINT – model and decision support systems for intermodal terminal networks* performed by a consortium consisting of:

- TFK – Transport Research Institute Borlänge – Coordinator,
- h2 projekt.beratung KG, Vienna,
- Rapp Trans Ltd, Zürich,
- Royal Institute of Technology, Stockholm,
- School of Business, Economics and Law, University of Gothenburg,
- University of Natural Resources and Life Sciences Vienna.

The MINT project is a joint strategic and tactical trans-national project researching models and decision support systems for evaluation of intermodal terminal networks. The outcome of the project will be a system of models and methods to investigate, analyse and evaluate terminal networks as well as single terminals. The system is based on a number of models on different system levels. By combining these models a more complete spectrum of effects can be analysed. This work has been complemented by an additional deepening network analysis which integrates non-modelling aspects in the analysis.

The aim of this report is to give an introduction to the MINT project, to give an overview of the different work-packages and to give a hint of the conclusions that could be drawn from the different parts of the project. This is not a summary of the project but could be used as a reading instruction.

Hereby, the coordinator, the authors and all project partners would like to address their gratitude to the funding organisations, all industrial representatives and other respondents who kindly agreed to be interviewed and helped us to make this report possible.

Falun, September 27th, 2011

Bo Östlund

Project coordinator

Table of content

1 WP1 State-of-the-Art

The aim of the work-package is to provide a state-of-the-art description of the current design of intermodal terminals and intermodal transport systems, i.e. to describe the dominating design of the system including its functions. The knowledge how to produce intermodal transport and to operate terminals is not only tacit knowledge within the Intermodal operators, but has also been transferred and further developed by Universities, Research Institutes and Consultancies. The latter organisations have developed models and decision support systems for evaluation of intermodal terminals and terminal networks. There are a large number of research publications and reports in this field, but there are also a large number of models and support systems developed in-house.

The work-package is focused on four aspects:

- *Glossary and Definitions* deals with the nomenclature for intermodal freight transport.
- *Intermodal transport in the MINT corridor* contains a description and analysis of the intermodal freight transport systems in Austria, Germany, Norway, Sweden and Switzerland with an outlook and comparison with the rest of continental Europe.
- *Interviews with intermodal actors and authorities* present models and tools used by actors and authorities to investigate, evaluate and analyze costs and benefits for terminal networks as well as single terminals.
- *Strategic intermodal Freight Transport Models - A Literature* Review covers what could be found in research literature concerning modelling of intermodal freight transport.

1.1 Glossary and Definitions.

1.1.1 Aim

By reading relevant literature and discussing intermodal transport with different actors and researchers it is obvious that the nomenclature is not clear. The first step in WP1 was therefore to define essential concepts and notions related to logistics, transportation and above all intermodal freight transport.

1.1.2 Methodology

This task has been performed as a desk study. Concepts, definitions and other notions have been collected from three different sources: (1) academic reports and articles, (2) national and European databases and (3) expert interviews. A draft version of the glossary was created and reviewed by the MINT partners. A final deliverable was published after a final revision.

1.1.3 Results

The work has resulted in a report containing general definitions, which is followed by two chapters discussing: (1) capillary infrastructure and above all (2) the notions multimodal, intermodal and combined transport. The glossary could be used on its own as a compact dictionary for the freight transport area.

1.2 Intermodal transport in the MINT corridor

1.2.1 Aim

The aim of this part is to describe and analyze the intermodal freight transport systems in Austria, Germany, Norway, Sweden and Switzerland, based on the actor, activity and resource perspective (ARA). This perspective is supplemented by a description of the competitive situation for intermodal transport in each country based on internal and external factors as phase of deregulation, transport policy, infrastructure regulation (as loading profile, weight dimensions) and finally some aspects related to the competitive situation towards road transport is singled out.

1.2.2 Methodology

The Scandinavian empirical knowledge for this description and analysis is based on a large number of semi-structured interviews with representatives from the intermodal industry, transport authorities, forwarders and shippers, reviews of scientific literature, reports and statistics.

The German empirical knowledge has been derived from reports of the national German statistical office, which since 2004 has collected data for intermodal transport based on their own methodology in addition to traditional mode by mode and global statistics.

The Swiss empirical data, statistics and graphs are based on previous reports, mainly made by RappTrans. The data has been updated by information received in informal interviews and official statistics.

The Austrian empirical data, statistics and graphs are based on a work package report of the DIOMIS project (cf. DIOMIS 2006). The data has been updated by information received in informal interviews and official statistics.

1.2.3 Results / Conclusions / Main issues

This part starts with an overview of the intermodal transport system in Europe – how it works, the transported volumes and how it has developed recently. The project is concentrated on the MINT corridor Scandinavia – Germany – Austria/Switzerland and the description goes into detail for the corridor and the concerned countries.

The following chapter describes the Rolling Road concept and how it has been developing (or not) in the different countries.

The development of the demand of intermodal freight transport is followed by a rather thorough description of the supply side covering different intermodal operators. The terminal network in the MINT corridor is described with details on handling volumes and terminal capacity.

Operational structure and philosophies are described as an introduction to a thorough description of the production system including technical details on road transport systems, rail engines, freight wagons, loading units and terminal resources. Finally some innovative production systems are described.

The chapter is completed with an overview of information and communication systems in use and the transport policy framework governing the intermodal freight transports.

A final conclusion is that the decreasing free infrastructure capacity is and further will be a problem for intermodal freight transport in the future. The prioritization of passenger transport in combination with lack of terminals (geographical coverage), lack of standardized load units and administration hampers the competitiveness of intermodal freight transport.

1.3 Interviews with intermodal actors and authorities

1.3.1 Aim

The aim of the MINT project is to develop a comprehensive model and decision support system of compatible and integrated models and to describe methods to investigate, evaluate and analyze costs and benefits for terminal networks as well as single terminals. Evidently an important basis for the project must be a good knowledge of what kind of tools that are used in the process today. Therefore, an interview survey has been carried out among key actors with a potential interest in modelling of intermodal transport in Sweden and Germany.

1.3.2 Methodology

The task started with the development of a semi-structured questionnaire (appendix 1) aimed at actual and potential users of model systems. The purpose of the interviews was to get an overview of the use of models in the industry and research community today and to identify strength and weaknesses with the used models.

The respondents were selected to represent organisations involved in the design and evaluation of intermodal terminal networks on a strategic or tactical level. The selection was based on the participating researchers several years of experience from intermodal transport research. All organisations identified as potential model users were contacted.

1.3.3 Results / Conclusions

The interviews reveal that there are a lot of different model approaches to analyse demand, supply and operations of intermodal freight transport. Most of these models are not specially developed to model intermodal transport systems but freight transport in general or rail transport systems. Therefore they have weaknesses to model intermodal transport chains and intermodal operations.

There is no apparent lack of models, but the models used, tend to be local models used only by the own organization or by a few organizations. There is no clear market leader among the models. Many of the locally developed models are not publically available, which also limits the number of potential models to choose from.

The large workload included in developing the models might also be a reason for the commercial companies to avoid using models. Government agencies, that use more models, have a responsibility to supply the government with decision support concerning intermodal investments etc. This decision support must, for political reasons, be based on quantitative numbers. It is difficult to imagine a government deciding on building a new road because it "feels right". Tacit knowledge, experience and simplified calculations are allowed to play a much larger role in decision making in a commercial organization.

The potential user of a new model system, such as MINT, is clearly government but also railways and intermodal service providers which also own and operate terminals. The use of models is a long term process for the organizations where they expect to be involved in the development and adaptation of the model for their purposes. A new system must either adapt to this or be able to provide a simple and fast solution to target the more commercial modelling market.

1.4 Strategic intermodal Freight Transport Models - A Literature Review

1.4.1 Aim

The MINT-project aims at developing a new model and decisions support system for intermodal freight transport. As a part of the MINT-project, a review of existing freight models is made in this report. The review will mainly be based on previous reviews by other researchers, on-line databases, previous knowledge of models among the partners in the MINT-project and the results from the model user interviews.

1.4.2 Methodology

There exist a large number of transport models. The MDir (Model Directory) database, for example, lists 306 transport models only in Europe[1]. The models vary from very large and

[1] Available on-line at http://www.motosproject.eu/?po_id=mdir Accessed October 2009.

complex models covering both passenger and freight transport, all transport modes and a large geographical area, to smaller models of only one mode in a limited area. The level of aggregation and simplification is also different between the models.

The focus is on computer models with a similar purpose as the intended MINT-model. The models must also be standalone computer software(s) implemented in a (more or less) user friendly environment. Pure mathematical models are thus not included. The demand for transport can be given externally.

1.4.3 Results / Conclusions

The report gives a good overview over both the most common and the most advanced transport and terminal models. Concerning transport models a short description of 15 models is given and 8 terminal models are presented in brief.

The review gives an overview of existing models within the intermodal transport sector. The models found are either focused on an overall strategic level or on specific details in the system, e.g. terminal operations. There are models covering all fours steps of transport modelling and all levels of the transport system, but these models do not model the system in detail. On the other hand, those models that are very detailed only cover a limited part of the modelling steps and transport system levels.

No model has been found that combines both a detailed modelling with a strategic perspective. This shows that there is a lack of models combining these two levels. This is not surprising as models traditionally have been developed for specific purposes, e.g. national planning, and therefore for budget and simplicity reasons has been limited to that level. It appears as no attempts have been made to link models from the different levels together.

2 WP2 Framework for strategic integrated terminal network evaluation

Work package 2 aims at creating a framework for evaluating terminal networks. This includes identifying the relevant actors in the system, their aims and goals and the assessment approaches used. This will be used as a base for the further model development within the MINT project, aiming at integrating a number of new and previously developed models into a common framework.

2.1 A systems view of the intermodal system

One of the first steps when modelling or developing a computer system is to agree on a common view of the system being studied. This analysis step, in which the real-world system is analysed, is commonly based on systems thinking. This means that the focus is on understanding the interrelationships between the parts in the system rather than the traditional linear cause-and-effect chain. The focus is on the relationships between the parts in the system and not the parts themselves.

One way to start the analysis is to create a so called "rich picture" that displays the system, or situation, in an as neutral way as possible. The function is to "display the situation so that a range of possible and, hopefully, relevant choices can be revealed. This step is illustrated in the report through a comprehensive illustration of the intermodal transport system. Based on the rich picture, a "conceptual model" is developed that is listing the activities in the system.

This list is then transformed into a conceptual model describing the intermodal transport system (see Figure 1). The arrows indicate dependencies between the activities. The thick black line represents the system border. The different activities are explained in the report.

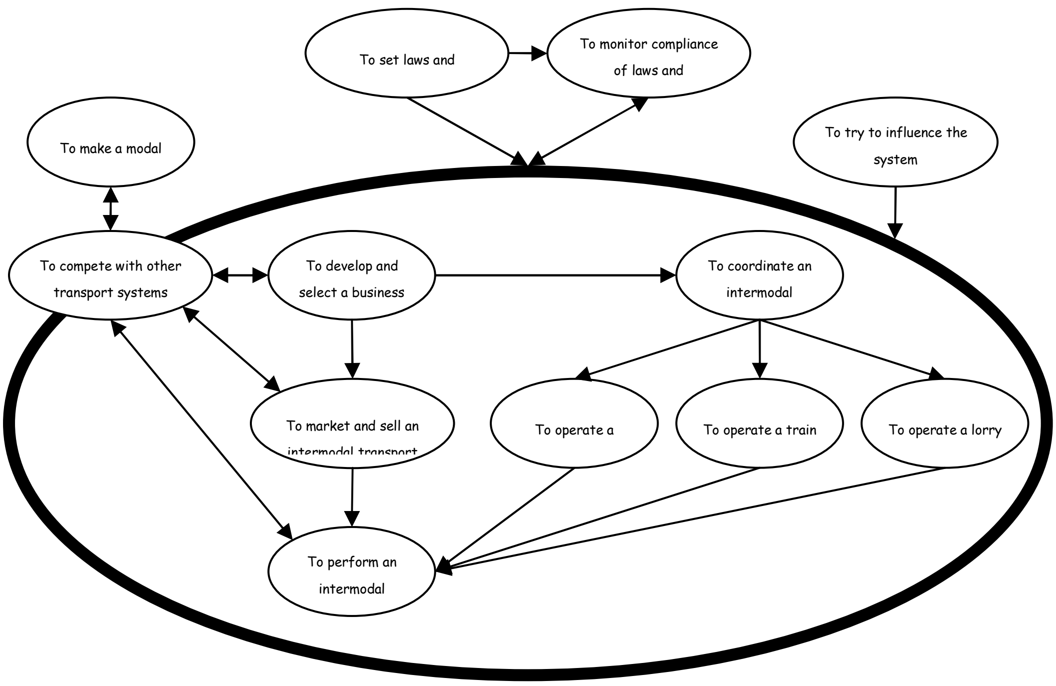

Figure 1: Conceptual model of intermodal transport system

To complete the systems view of the intermodal system the actors involved in the different activities are identified and their involvements in the activities are described.

2.2 Important factors for the actors

The actors involved in the intermodal transport system have different goals and aims with their participation in the system. Some are just interested in cheap transportation service, some are interested in reduced environmental impact, while others are interested in making a profit, etc. It is important to investigate the important factors for the different actors to ensure that a modelling system can cover these factors properly. The most important actors are the transport buyers; that is why they have been investigated in detail. This is then followed by a review of the important factors for the other actors.

2.3 Analysis methods for decision makers

For taking a decision on an investment the decision makers need a sound basis for prioritizing between different alternatives. This basis should cover all important factors that can be measured in monetary terms, but also non-monetary factors must be taken into account. The assessment approach implies to find a methodology to balance the different factors in a transparent process leading to a solid base for decision (Figure 2). This is done in a three-step process:

- defining possible/suitable project alternatives,
- identifying and calculating effects of the improvements and
- evaluating these effects in an assessment process.

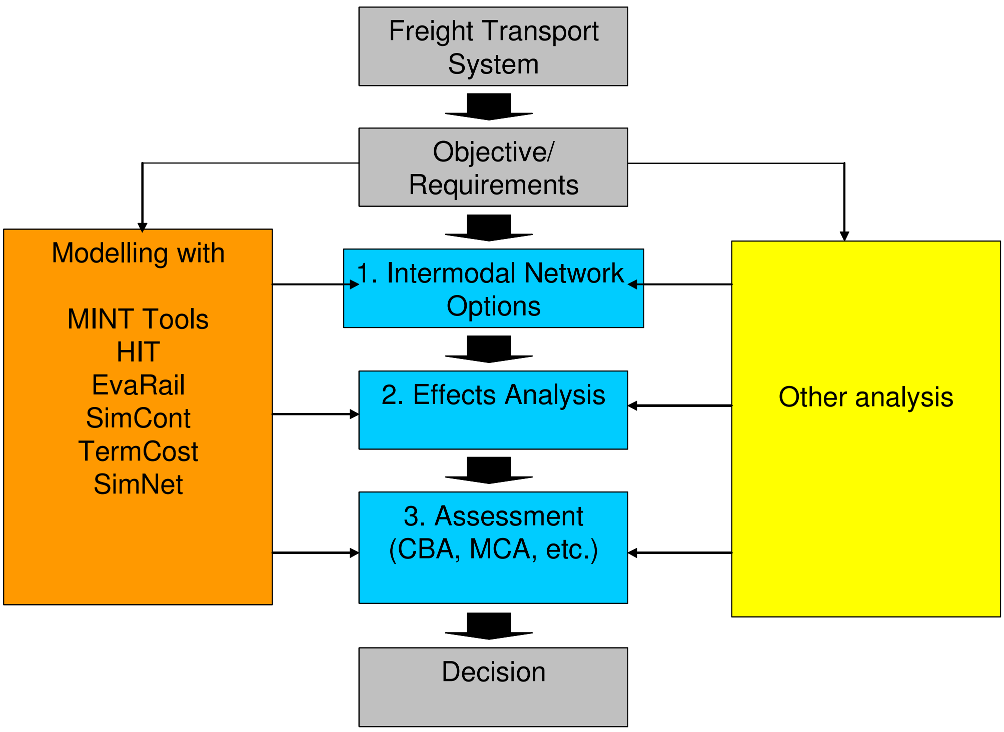

Figure 2: Evaluation process

2.4 User Cases

A number of user cases have been defined. Their intention is to give examples of some important questions the MINT-modelling system could be used to solve. The cases show the interest of different actor groups in the questions and how the MINT system is used to model this.

For every user case the goals and interests of the system actors and stakeholders have been defined, and the several tasks and subtasks of the user cases allocated to the interested parties. Furthermore, a definition which model(s) will be used to solve a task was done. The system actors and stakeholders are: Terminal operator, Government, Forwarder, Shipper, Railway Company (train operator), Railway infrastructure, Haulier, Intermodal service provider, and Consumer.

The following user cases have been analysed:

- Terminal location planning
- Determining modal split and terminal network design
- Infrastructure investment analysis
- Performance evaluation of the network
- Terminal design
- Performance evaluation of terminals

2.5 Conclusion

The investigation of the actors, their goals and potential use of the MINT model system shows clearly that there is a need for the MINT system, where different models are combined. In particular, the user cases show that no model alone can answer all important questions, but by combining several models it is possible to make a great leap into providing good decision support for actors in the intermodal industry.

It can be concluded that the MINT model system is most appropriately used as a decision support system (DSS) which supplies input for the decision making process.

3 WP3 Modelling and simulation of intermodal terminal networks.

Following the aim of the project to develop a new and improved strategic model and decision support system (framework) for evaluation of intermodal transport and terminal networks, first the scope of the already existing models EvaRail, HIT and SimConT was aligned with the various (sub)areas of the intermodal transport system and research questions for the MINT project were defined. In the next step, the different interaction possibilities of the models were evaluated. Thus a comparison was made which output data of one model can be input data for another model.

These evaluations showed the need for complementing and filling gaps of the focus and scopes of the existing models. For this purpose, one model for calculating total costs of intermodal terminal operation (TermCost), and one conceptual model, which incorporates terminal operation and link operation (SimNet), was developed.

3.1 The SimConT model

The purpose of the model is to implement a simulation based methodology, which can be used while designing new rail-rail or rail-road container terminals (HCT) or extending existing ones and which enables the comparison of different material handling technologies, shift patterns, resource scheduling, operational philosophies and infrastructure capacities.

The simulation of container terminals is an approach for efficient resource-planning and effective capacity analysis of HCTs, which is based on modern object oriented simulation techniques. By means of simulation different material handling technologies, shift patterns, resource scheduling and infrastructure capacity are analysed. Further, optimisation is used in order to find optimal configuration parameters.

3.2 The Heuristic Intermodal Transport Model (HIT)

The Heuristic Intermodal Transport model takes its starting point in a competitive situation between traditional all-road transport and intermodal transport, where the theoretical potential of intermodal transport is determined by how well it performs in comparison with only road transport. The model can also be used as a calculation tool to calculate the costs and environmental effects of a given transport system. The optimisation and calculation functions can also be mixed, where some parts of the transport system design are given by the input data and the remaining parts are optimised.

Output from the model is the modal choice for a specific shipment occurrence with departure time, arrival time, train departure used, position on train, type of lorry used, number of lorries used, business economic cost, social economic cost, environmental impact (CO_2, CO, SO_2, NO_x, PM, HC, energy consumption and a monetary estimation). If all-road transport is selected, the model also shows the reason why intermodal transport could not be selected (e.g. violated time constraint, economic constraint, etc.). The suggested train system is output with time tables, train lengths, business economic costs, social economic costs and environmental impact.

3.3 The EvaRail model

EvaRail is an activity-based rail freight costing model developed at the Royal Institute of Technology Stockholm (KTH), programmed in VBA (Visual Basic for Applications). The model depicts the rail freight system in form of three main levels, the infrastructure, the train services and the freight flows, which are interconnected to each other: The rail network is depicted by nodes and links, where the nodes represent stations, terminals, etc., while the links represent the railway lines in between.

The next level is the train service level, containing detailed information about the train services offered on the network, e.g. timetables, operating days, train length and weight limits, etc. For the freight flows the information comprises the commodity, origin and destination, quantity per year and per shipping occasion, desired departure times and time windows for loading and unloading at the consigners and consignees location.

3.4 Conclusion on the MINT model portfolio

Both the HIT and EvaRail models are limited to the depiction of network links and the SimConT model focuses on the internal operations of terminals. As a consequence, interactions and dynamic interrelations inside a transport network (consisting of several links and nodes) cannot be evaluated with the existing models alone. The limitations of the existing models for performing network analysis can be summarized as follows:

- SimConT: model scope of detailed analysis of terminals; does not include shunting.
- HIT: includes local road transport (haulier and forwarder) and railway for modal split calculation based on cost comparison; does not include terminal parameters in the calculation, cannot handle shunting or train-to-train transshipment, no dynamic analysis over time possible.
- EvaRail: routes transport demand through a given railway network (infrastructure and train products), cost calculation for the flows, includes shunting, no terminal parameters are considered.

As the aim of the project was to define a framework that allows for a comprehensive network analysis, it was decided in the project to fill this gap by designing the concept for a new model named SimNet. Further, to complete the possibility of network cost analysis, the TermCost model was developed to cover the cost calculation for terminals. The scope of these new models can be summarized as follows:

- SimNet: covers terminal network with terminals and road and rail connections at a more aggregate view than SimConT and EvaRail. Shunting is not considered.
- TermCost: calculates terminal costs for infrastructure and operation.

3.5 The TermCost model

The TermCost model has been developed as a standalone model with the aim to be able to calculate the transshipment costs for a certain time period based on a given input and resource configuration, given a maximum utilisation.
Used as a standalone model or in combination with SimConT, different terminal alternatives can be evaluated. By changing the objects and attributes, different alternative scenarios might be evaluated relatively to a base scenario.

The results of such an analysis might be, e.g. (1) the total costs for a certain time period, (2) the costs per handled TEU for a given time period and (3) costs per input attribute type for a given time period. The input attribute types in the basic configuration are: (1) investment costs, (2) maintenance costs and (3) operational costs.

3.6 The Terminal Network Simulation Model (SimNet)

As the existing MINT-models focus on the three nearly independent areas of modal split calculation, link operation and terminal operation, the aim of this task was to develop a concept in order to expand the MINT-model scope, in adding the possibility to conduct network analyses by integrating terminal and link concerns.

The SimNet model is conceived as a multi agent simulation tool which intends to compare the performance of intermodal networks, given different network settings (physical network topology or functional network structure) and different operational concepts (train concepts, truck arrivals). Further, the model aims to coordinate the flow of load units in the network in case of network element overload.

The network performance can be evaluated in terms of the throughput time of the load units, overall transportation costs (given cost factors for the usage of the different network nodes and links) or utilisation measures of the individual network elements.

3.7 Data exchange between existing and new models

The next step in the project was to define how the "old" and the new models could be integrated, respectively interact with each other. To figure out the models' similarities and dissimilarities in depicting (parts of) the intermodal system, a pair wise comparison of the models was done in order to explore suitable model interfaces.

The evaluation of comprehensive questions in functional and contextual regard, exceeding the individual model scope, can be carried out by interactions of the different models. The difficulties in the cooperation of the models are given through their already mentioned varying application focus and input and output data granularity. Thus, it is of special relevance which data transformations are required to enable model interaction and data exchange. For different research questions different constellations of model combination and sequence will be adequate to be solved. Figure 3 shows the generally possible data flow between the models and their application sequence. If one of the models is not used potential missing input data will be substituted through external sources, or may already be given through a model earlier in the chain.

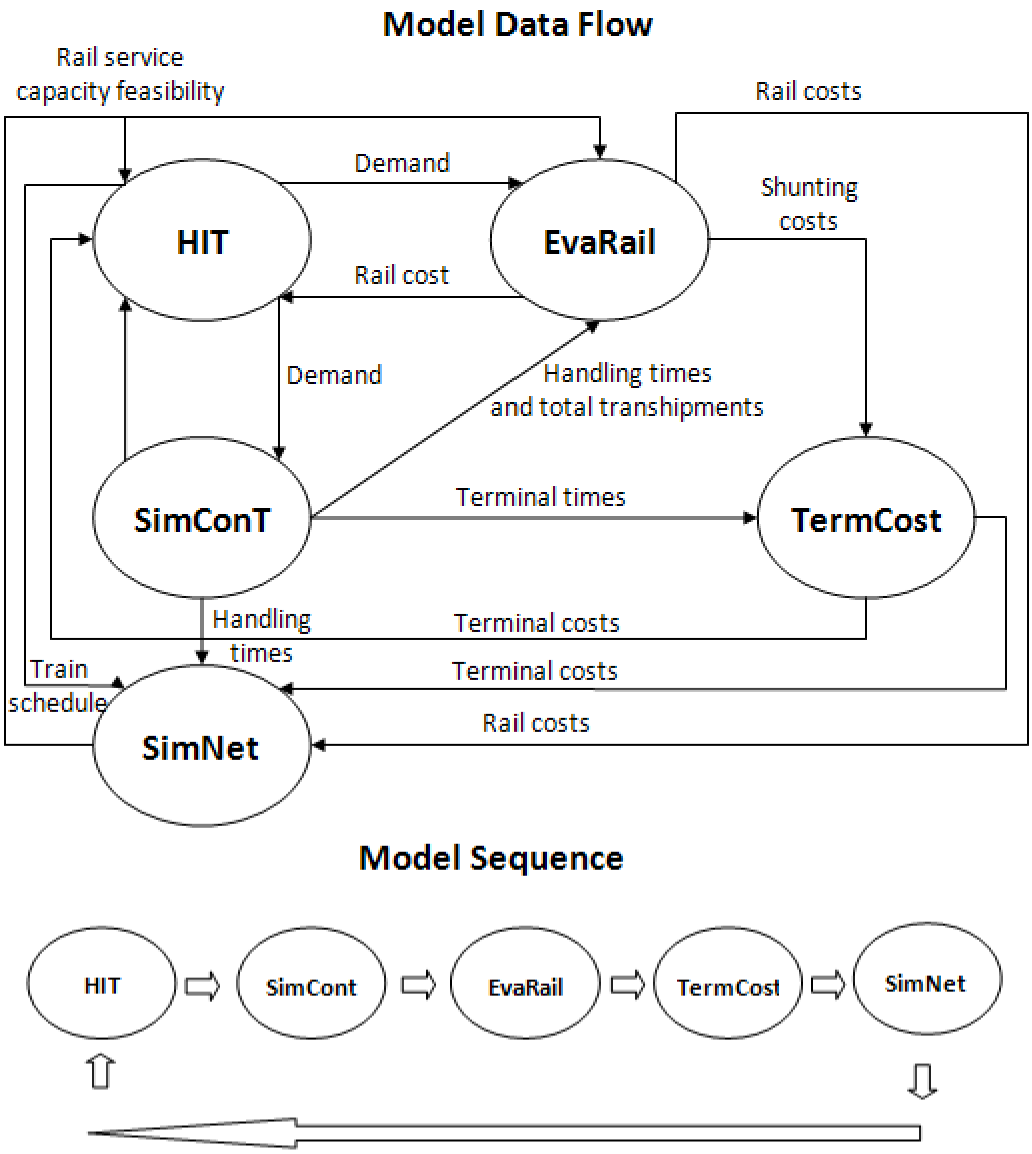

Figure 3: Model data flow

3.8 Implementation of needed model extensions

One of the aims of the MINT project was to highlight the conclusions from the TERMINET project (Trip and Kreutzberger, 2002), i.e. to put attention on line networks and line terminals. The intermodal bundling concept (network structure or operational philosophy) are important for small and dispersed freight flows or as regional feeder systems for the national/international trunk lines. However, the importance of line networks has been underestimated, and little has become known about their costs and performance. Hence, to cope with this special form of intermodal networks, the MINT model-portfolio was adapted by developing an extension of the HIT model and implementing a SimConT mini applet for line train terminals. These extensions, including adapted measures for internal and external performance, were also a prerequisite for a Case Study on a liner train terminal system.

3.9 MINT-model validation

Generally, model verification and validation are essential parts of the model development process if models are to be accepted and used to support decision making. For the MINT project this is essential to ensure that the specification is complete and that mistakes have not been made in integrating the models for their application on the case studies.

The existing models of the MINT-portfolio were validated and tested successfully on their own. As no physical combination of the models will be made, there are no further validation processes necessary for them. However, regarding the new developments this step has to be done. The TermCost model, the line train functionality of the HIT model and the SimConT mini applet for line terminal networks will be tested by their application in case studies. In the preparation of the case studies, the data requirements and model data exchange possibilities have been evaluated according to the model interaction possibilities presented in chapter 5. On basis of the user cases defined in WP 2, two case studies have been elaborated in order to answer questions regarding the performance of an intermodal network. The case studies were carried out conceptually by using the existing simulation models HIT, EvaRail and SimConT and the new models TermCost and SimNet.

4 WP4 Deepening Network Analysis

Experiences with terminal network planning projects and terminal location evaluation studies show that not all aspects which are relevant for decision making and implementation of intermodal terminal networks can be estimated by modelling tools. Therefore modelling and simulation results have to be combined with results of further analysis. Such analysis covers aspects of spatial planning (national, regional and local level), technical, financial and political feasibility and regional aspects. These aspects can play an important role looking at terminal networks and intermodal systems.

The objectives and tasks of WP4 were:

- To identify relevant aspects of terminal network / location planning and evaluation which cannot be modelled or simulated.
- To concretise and present procedures and methodologies to analyse and evaluate intermodal terminal networks and locations to complement the modelling approach.
- To show the interplay between modelling and deepening network analysis.

4.1 Identification of relevant aspects which cannot be modelled

- Relating to economy the MINT models output covers very well the efficiency, capacity and cost indicators; but also accessibility and quality indicators. The modelling output does not cover indicators relating to regional economy, side effects and realisation.
- Relating to environment the MINT models output covers very well pollution, climate change and energy consumption indicators. The model output covers the surface only partly and does not take into account indicators relating to land use planning, overall appearance of locality, water/groundwater, nature conservation and landscape conversation.
- Regarding society, safety indicators are covered only partly by the models of the MINT project. Indicators relating to security, provision of goods, urban quality, acceptance and labour market are not covered.

For a complete assessment from an authority point of view, the analysis with the MINT model portfolio must be extended by further analysis especially regarding societal and environmental targets and indicators.

4.2 Procedures to analyse and evaluate intermodal terminal networks

Based on good practices, the procedures and methodologies to analyse and evaluate intermodal terminal networks and locations to complement the modelling, were concretised and presented. The procedures and methodologies have been further developed to meet the requirements for efficient and high quality analysis and evaluation of intermodal terminal networks.

In WP4 three different procedures are outlined and discussed:

- A general planning procedure for intermodal transport systems.
- A procedure apt to terminal location planning.
- A procedure for terminal design.

4.3 Methodologies to analyse and evaluate intermodal terminal networks

4.3.1 Methodologies for effect analysis

Depending on the stage and the complexity of the analysis, different methodologies which require different levels of effort could be used. In the first rough evaluation rather simple methods could be sufficient to search alternatives that fulfil the minimum requirements for the main actors. In the following stages of the work the level of detail must be more precise with efforts to forecast future demand and describing the necessary investments to meet this demand as well as the costs for the investments.

The costs for freight transport infrastructure investments and maintenance are high. Still the existing methodologies for effects analysis are to a great extent inadequate and the different models are not easy to combine. The MINT model portfolio is developed to facilitate the analysis with a comprehensive and coherent set of tools.

WP4 gives an overview of how different aspects of effects of investments can be analysed using different parts of the MINT tools.

4.3.2 Methodologies for assessment

To be able to make a decision on how to improve the intermodal terminal network, it is necessary to calculate the costs and effects of different proposed improvements, but also to have the adequate methodologies for the assessment. The project focuses on socio-economic assessment methods.

Intermodal transport systems are space relevant and usually need bigger investments. Therefore, important decisions have to be taken by authorities and private parties. Such decisions can be

- decisions on infrastructure investments (new terminals, extension of existing terminals, rail links between terminals, access roads to terminals etc.),
- decisions on the implementation of new intermodal services,
- decisions on terminal locations,
- decisions on the design and equipment of terminals and
- decisions on investments in rolling stock.

For such decisions an assessment of different options and solutions is needed which is taking into account the requirements and objectives of the decision makers. This assessment should be an “overall” assessment considering all relevant effects.

Ordinal methods (Index-assessment, Ranking and Qualitative assessment) are comparably easy to use and are used in early stages of the planning process. They are also suited for completing a quantitative analysis for factors that cannot be valued in monetary terms.

By an in-depth analysis of an investment, *quantitative, cardinal methods* are used, where the costs and benefits are measured in monetary terms as far as possible. In WP4 Cost-Benefit-Analysis (CBA), Multi-Criteria-Analysis (MCA) and Cost-Effectivness-Analysis (CEA) are briefly discussed.

5 Conclusion

To conclude we can state that within the MINT framework *Modelling and simulation of intermodal terminal networks* we were able to further develop modelling approaches for overall analyzing intermodal networks and pave the way for more enhanced model developments.

The concept to bring together researchers from different organisations with different backgrounds and complementary competencies have given a broader view of the research area and also some insights in the actual planning practise in different parts of Europe.

TfK

Rapp Trans

BOKU

[h2 projekt.beratung]
research – consulting – project management

KTH
VETENSKAP OCH KONST

UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW