





Freight transport analysis in cross-border transport corridors

European Union





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Executive summary

This report is a delivery within GreCOR Work package 3 as a sub-delivery within activity 3:1.

A whole new generation of freight modelling approaches was developed in the early 1990s. As with all ideas and approaches, some are more likely to reach the market than others. Many of the approaches that were developed had a hard time making it beyond the scientific literature, mainly due to heavy data requirements or simply lack of demand and interest by policy makers. Today, with increasing pressure on government to effectively deal with growing freight flows and greening of the transport system, the demand of freight models are increasing and most countries within the European Union have developed their own national freight transport model which all have different requirements, possibilities and capacity compared to other countries.

The demand is increasing and there is today a greater need for freight transport analysis, not only on national level, but along cross-border transport corridors to allow for a holistic view when planning of the transport system. This is today even more relevant as nine core network corridors were established with corridor managers (European Coordinator) to make sure that the corridors are developed effectively and efficiently.

This short report brings up some examples of European freight transport models that can be used for transport surveying as well as action analysis. Moreover, available transport statistics is also shortly reviewed. The geographical scope of the selected national models is countries included in the transport corridor Oslo - Randstad. This is followed by a recommendation for further development and actions.

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GreCOR – Green Corridor in the North Sea Region

GreCOR – Green Corridor in the North Sea Region – is an Interreg IVB North Sea Region project that started 1 January 2012 and will end in June 2015. GreCOR promotes the development of a co-modal transport corridor in the North Sea Region. Important in this collaborative approach, is the that the focus is not only on the corridor itself, but also on secondary networks and the hubs, and the regional hinterland around the Green transport corridor between Oslo and the Randstad area (<u>Amsterdam</u>, <u>Rotterdam</u>, <u>The Hague</u> and <u>Utrecht</u>).

GreCOR has 13 partners and a total budget of 3.7 M€. The overall aim is to improve knowledge about the logistic needs and conditions and develop a strategy for the further promotion of environmentally friendly transports in the corridor. GreCOR focuses simultaneously on infrastructure and logistics for "greening" of transport and to make the region more competitive. The activities in GreCOR and the strategy will be a contribution to the EU objectives for transport as expressed in the White paper from 2011 "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system"

The work in GreCOR was performed in seven work packages. More information at: www.grecor.eu



Figure 1. Map of the Corridor including locations of all project partners

Inventory and analysis for Green Corridor development

This report is part of Work Package 3 - Inventory and analysis for Green Corridor development and is a sub-delivery within activity 3:1.

Background

Freight transport models have been around in the transport research since the early 1960s, and appeared, during that time, more or less in parallel with passenger transport models. As freight transport increased within the area of public publicity, also the interest to refine it from the passenger transport models increased.

In the 1970s, freight was largely treated by the research community in a simplistic way, as a separate class of passengers, leaning on the same theoretical underpinning and the same applied models. During the same time period, however, new freight-related disciplines emerged, like logistics and supply chain management, aiming at improving firms' logistics. As a consequence, a whole generation of new freight modelling approaches was developed in the late 1980s and early 1990s resulting in a wide range of approaches. As with all ideas and approaches, some are more likely to reach the market than others and as of today there is a wide range of different models and approaches. (de Jong, et al 2014) In present time increasing pressure on the government to effectively deal with growing freight flows and holistic management of the infrastructure, the demand is increasing and so is the pressure on available freight transport models.

This is today even more relevant as nine core network corridors (see appendix A) were recently established within the European Union to make sure that the corridors are developed effectively and efficiently by:

- Removing bottlenecks,
- Build missing cross-border connections and
- Promote modal integration and interoperability.

As most freight transport models available today have a national focus, the need is now increasing to also enable transport analysis in cross-border networks.

Work package 3 consist of four different activities which results in several subdeliverables. This report is part of activity 3:1.

- Activity 3:1 Identification of freight flows and standard development
- Activity 3:2 Mapping of on-going and planned projects and initiatives in the corridor and its catchment area
- Activity 3:3 Analysis of bottlenecks and gaps in the transport system of the green corridor and the secondary network
- Activity 3:4 Develop a general method for how to measure the environmental consequences of the operations in the green corridor including the logistic hubs

Purpose & Aim

As one of the intended outcomes within GreCOR WP 3 is to develop a standard for analysis and presentation of data for cross-border freight transport analysis, this report aims to present an overview of the state-of-the art in order to give recommendations of how to proceed with available freight transport models and data for the purpose of the GreCOR project. Therefore, this short report brings up examples of European freight transport models that can be used for transport surveying as well as action analysis. Moreover, available transport statistics is also shortly reviewed.

Delimitations and focus

The geographical scope of the selected national models is countries included in the GreCOR transport corridor.

Work package 3 in GreCOR

The goal in work package 3 is to provide the grounds for the development of the first green corridor in the North Sea Region.

Freight transport analysis in cross-border transport corridors

There is today a need for freight transport analysis along cross-border transport corridors to allow for planning of the transport system. The need mainly concerns transport surveying, but also action analysis is needed. The information about the freight flows that typically is being requested is the freight volumes in ton kilometres, the traffic modes used for different volumes, origin-destination (O-D) of the freight flow, and the commodity types. To allow for freight transport analysis, freight transport analysis models are typically used. In such models, freight transport flows appears in the transport network. In national and international transport models, the freight transport flow is typically described as flows between different zones. The size of the zones differs between different models.

In the next section, a selection of national and international freight transport models used today for freight transport analysis in the GreCOR region are presented. Then, available transport statistics is shortly presented. Finally some recommendations are given regarding cross-border freight transport analysis of transport corridors.

Freight transport models

National freight transport models are typically designed to be used for national purposes, i.e., national freight transport forecasts, transport surveying, and policy analyses. Moreover, national transport administrations typically want to conduct costbenefit analyses from the model results in order to assess the benefits of suggested actions on the transport system. However, the models typically include transport to and from the country, why it can be used for studying transport to and from a country/region. Freight transport models are typically based on transport and foreign trade statistics, transport cost data, and network data. Since it is time-consuming to conduct surveys, for instance regarding commodity flows, as well as to update the national models with new data, the models often rely on old data. As an example, the Swedish model Samgods relies on data for the year 2006 and the European model TRANS-TOOLS relies on data for the year 2000.

The predominant model type for supporting the decision-making in public authorities is the sequential and aggregate (macro-level) four-step approach (see, e.g., de Jong et al., 2004), which include one or more of the following steps: trip generation, trip distribution, modal split, and traffic assignment. In addition, they often adopt the socalled ADA (Aggregate-Disaggregate-Aggregate) approach: they start with aggregate data, which is then disaggregated in order to enable to generate detailed estimations of logistics choices (e.g., of vehicle types and consignment sizes), and finally aggregated for further processing. Examples of four-step models that adopt the ADA approach are Samgods (Swahn, 2001; de Jong et al., 2010), TRANS-TOOLS (Rich et al., 2009), and the Danish Freight Transport Model (Rich et al., 2010).

Forecasts are typically based on assumptions regarding the national and regional economic development for different industries and planned infrastructure investments. Below some examples of national freight transport models along the corridor Oslo - Randstad is briefly described, followed by a few international transport models along

the corridor. For further details of the respective models, please consider the model documentation. Table 1 summarizes the main characteristics of the described transport models.

The national freight transport model in Sweden is called Samgods (de Jong et al., 2010) and has been used for transport surveys (e.g., Freight Flows in Eastern Mid-Sweden (Vectura, 2012)), as well as for policy analysis and transport forecasts (e.g., Swedish Transport Administration (2013). Besides including transports in Sweden, Samgods includes transports to and from Sweden from abroad. The transport flow appears between municipalities. Samgods is currently undergoing a development project where an official version of the model will be released during 2014.



Figure 2. The picture illustrates example of output from the Samgods freight transport model. The picture to the left shows transported road freight by volume, the picture to the right shows total freight transported by sea and rail (source: Vectura, 2012)

Another transport model which is sometimes used in Sweden for freight transport policy analysis related to road transport is Sampers (Beser and Algers, 2001). Sampers does not include freight, but lorries, why OD freight flows are not captured, as in freight transport models.

Norway also has a national freight transport model, and the development of the logistics model was conducted in parallel with the development of the Swedish model system Samgods (Vierth, 2011; Significance, 2013). The model system consists of three parts: a model to produce demand matrices, a logistics model, and a network model. The PINGO model is used to regionalize the national growth for different industries and regions. Freight demand matrices for the forecast year are used as input to the logistics model, which in term generates traffic mode specific ton-matrices and tonne-kilometres per traffic mode and region.

In the Netherland, SMILE+ have previously been used as the national freight transport model, but it is replaced by a simplified freight transport model called BASGOED (Vierth, 2011; Tavasszy et al., 2011) which is based on SMILE + (de Jong et al., 2011). BASGOED was during 2011 under development and the current status is unclear. BASGOED cannot handle complex freight policy issues, however, it promises to be less costly in maintenance and more transparent in operation. The model will be used for the evaluation of road, rail and inland waterway projects (Vierth, 2011). BASGOED uses the economy module of SMILE for calculation of the transport demand between zones in tons per commodity group. With logit models freight flows are assigned to OD flows on unimodal road, rail, and inner waterways. 40 zones are included in the Netherlands, 29 in Europe and 8 in the rest of the world.



Figure 3. The picture illustrates the tool BaseGoed. Showing exported volume of Distribution production (source: OmniTrans-international)

The German freight transport model (BVU, IVV & PLANCO, 2003; Vierth, 2011) is used for planning investments of the national road, rail and inland waterway infrastructure. The model was used for analyses to the investment plans in 2003 with 2015 as forecast year, and the model was updated 2007 for forecast year 2025. The model is also used for policy analyses, such as effects of the Maut, transport cost decreases for rail transport, and changes of the reliability of rail transport. Currently development projects are conducted to include sea and air transport, logistical choices regarding consignment size and load consolidation, as well as to reconsider the included vehicle types and transport chains. 439 zones are included in Germany and 50 zones outside Germany.

In Denmark, a new transport model has recently been developed, called LTM (Landstrafikmodellen), where a freight model is part of the overall model system (Rich et al., 2010; Haugsted Johansen, M., 2014). The aim is to enable analysis of different types of transport policies, infrastructure investments as well as economic developments. The freight model includes flows that are related to Denmark, i.e., national, international transports to and from Denmark, as well as transit flows. Moreover, flows outside Denmark that potentially can be moved to a fixed link across Fehmarn Belt are also included. Data collection that has been conducted for the model are: road-side surveys about industrial and city areas, interviews with firms involved in

freight transport, GPS-data (TetraPlan, Road Directorate and fleet data from logistics firms), and interviews with companies in Denmark, Sweden and Germany with international transport (Overgård Hansen, C., 2011). To allow for different aggregation levels for different types of studies, four zone systems are included in the model system. The most aggregate level includes 98 zones; while the most disaggregate level includes 3670 zones. Including more zones requires more computer capacity as well as input data (Rich et al., 2010).



Figure 4. Output from the Danish LTM model. The picture to the left illustrates traffic flows per day and the picture to the right illustrates the weighted accumulated driving time in minutes. (Source: Riff Brems, C. Technical university of Denmark, DTU)

National freight transport models in Europe are typically owned by the national transport administrations, but different types of organisations (the national transport administrations, consultancies, universities) can however administer the models (Vierth, 2011). In the case of TransTools (see model description below), it is owned by the EU and administered by JRC (Joint Research Center). The development is often conducted by consultancies and often developers are also model users. A general issue with freight transport models is that they are complex and therefore requires a lot from the users and for them to present the results. The models also have varying degrees of transparency. If the models are not transparent enough, it is difficult for new model users to use the model.

GORM is a Swedish-Danish freight transport model that includes freight transport in Skåne and Sealand (Swedish Road Administration, 2008). GORM is considered to have good quality since it is well calibrated (Holmgren et al., 2013); however, the data is old (1999-2003). Road transport is modelled with better quality than in particular rail.

There also exists a European transportation model, TransTools, which includes transport in 42 European countries (see Rich et al. (2009), Ibanez (2009), and http://transportmodel.eu/ for further information). The model both includes passenger and freight transport. TransTools is less detailed than traditional national freight transport models (Vierth, 2011), for instance the size of the zones is rather large. The model is more detailed in Germany and Western Europe, while for instance the Nordic countries are treated less detailed. The purpose with TransTools is to have a common European transport model to enable analyses of policies at the EU-level. For instance, TransTools has been used for the analysis of TEN-T guidelines, energy taxes, Eurovignette, and heavy goods vehicles. TransTools has also been used for transport surveying in for instance the Baltic Transport Outlook project (BTO, 2011). The model is considered to generate too rough results by model users and clients since the data that is used is on NUTS2 level, and is therefore not considered very reliable (Holmgren et al., 2014). As an example, in Sweden 8 zones are included. The data from which the model is based on is also regarded as old (Vierth, 2011). Especially for sea and rail transport, the underlying data is considered to have low quality. Moreover, the logistics modelling is considered too simple. See Ibanez (2009) for a summary of the issues with TransTools. There is an ongoing EU project, led by DTU, where the model is being further developed in an international project group (TransTools 3). For instance, the demand matrices will be on a finer level (NUTS3) than the current NUTS2 level, which will generate more detailed results.



Figure 5. Trans-Tools Rail freight assignment base year, tonnes per day. (source: Burgess, A. *et al.* 2008)

Besides models that are currently used today for freight transport analysis by public authorities, there is also more long-term research focusing on other types of models with the potential to be used for freight transport analysis. Such model types are primarily agent-based freight transport analysis models, e.g., INTERLOG (Liedtke, 2009) and TAPAS (Holmgren et al., 2012). Agent-based models belong to the class of micro-level models, where individual entities are represented and the relations between them are studied over time. In agent-based models, one or more of the entities, often decisionmakers, are modelled as agents. In particular, agent-based models enable to model the decision-making in freight transport, hence capturing causality.

For overviews of existing freight transport analysis models, please refer to (de Jong et al., 2004; Tavasszy, 2006; Hensher and Figliozzi, 2007; Liedtke, 2009; Chow et al., 2010; Holmgren et al., 2012).

Model	OD freight flow	Geographical scope	Traffic mode (freight)	Different freight/ commodity types	Data sources	Has been used for cross border corridor analyses
Samgods	Yes	Sweden	Rail, road, sea, air	Yes (34)	CFS, traffic counts, port, air, rail, and road statistics, foreign trade statistics, network data	Yes, Sweden-Finland (Kvarken)
Sampers	Yes	Sweden	Road	ON	Road traffic counts, road goods transport statistics,	ON
Norwegian model	Yes	Norway	Rail, road, sea, air	Kes	CFS, traffic counts, port, air, rail, and road statistics, foreign trade statistics, network data	No information
LTM	Yes	Denmark	Road, rail, sea	Xes	Road traffic counts, interviews, Iransport statistics	No information
BASGOED	Yes	The Netherlands	Road, rail, inland waterways	Yes (10)	SMILE+, transport cost data, network data	No information
German model	Yes	Germany	Road, rail, sea, air `	Yes (10)	Demand matrices, rail, road, and I nland waterway statistics, network data	Q
GORM	Yes	The Oresund region (Sweden: Skane, Denmark: Sealand)	Road, rail, sea	Yes (13)	⁻ oreign trade statistics, trade statistics, CFS, Samgods, SENEX	Yes, IBU Oresund
TransTools	Yes	42 European countries	Road, rail, sea, inland waterways, air	Yes (11)	Similar as traditional national models, but more course grained nput	Yes, e.g., Baltic Transport Outlook 2030, IBU Oresund

Table 1. Summary freight transport models.

Statistics

Different types of statistics are used when freight transport models are developed as well as for comparisons with the model results. The statistics can also be used separately to describe the transport system. The countries along the GreCOR transport corridor collects national transport statistics. The way the statistics is collected as well as how it is developed often varies between the different countries, why it is difficult to compare. Even within a country, for instance Sweden, the transport statistics varies between different traffic modes since they have different characteristics (Ramstedt et al., 2011). For instance, the commodity types that are used to describe the freight transport differ between the traffic modes. In Sweden, the commodity flow survey (CFS) includes detailed statistics of freight transport flows. A summary of the aggregated commodity flows are publicly available, however, detailed results from the survey are only available for universities for research purposes. Moreover, the statistics is only reliable for larger geographical areas – for smaller geographical areas the statistics is not reliable. In Norway a limited commodity type survey has been conducted.

European statistics is available from Eurostat. This statistics is in general more coursegrained than the national statistics. The statistics include summaries of transport volumes, for instance freight tonnes per NUTS 2-region and modal split (tonnes and tonnes-kms) per country. From the publicly available statistics it is however not possible to obtain freight flows between origin and destination. However, it is possible to obtain total amounts of freight volumes at NUTS 2-level for different traffic modes.

McKinnon (2010) brings up some issues with the available transport statistics at EUlevel, for instance regarding the vehicle utilization measure and the ton-km measure. Issues regard for instance that there are inconsistencies between net and gross ton-km. Table 2 summarizes the main characteristics of a selection of methods/models for the identification of freight flows.

Statistics/ method	OD freight flow	Geographical scope	Traffic mode (freight)	Different freight/ commodity types
Eurostat	No	European countries	Road, rail, sea, air	No
National statistics	CFS: yes, other: no	Sweden, and import and export flows	Road, rail, sea, air	Yes (Sweden, Norway)

Table 2. Summary of statistics

Summary and recommendations

Today, there is no single freight transport model or statistics that can handle crossborder transport surveying and action analysis without quality issues. National models can typically handle transports to and from the country/region, while the only international model that covers all countries along the corridor Oslo - Randstad is TransTools. However, the level of detail of TransTools is rather low, especially in the Nordic countries, and there are also other quality issues with the results. Often both freight transport models and statistics are used together to enable transport surveying of cross-border transport along transport corridors. Sometimes several freight transport models are used to meet the desirable needs. Which model(s) to use depend on the geographical scope and the purpose of the particular study. Below our recommendations for further development are summarized.

- Continue the research and development of existing freight transport models as well as new freight transport models in order to meet the increasing need for cross-border freight analyses. Today, the model that seems to best meet the needs to study and analyse cross-border freight transport is TransTools. There is currently ongoing research and development for this project. Moreover, Holmgren et al. (2014) suggest focusing on conducting supplementing substudies with different types of analysis models as well as developing hybrid models.
- Continue the research and development of data collection methods to improve the input used in freight transport models. In Sweden, a detailed commodity flow survey exists. If similar studies were conducted in other countries along the transport corridor, more data about the freight transports would be available. However, conducting commodity type surveys are expensive. In the future, there is a potential that ITS solutions may be possible to use to take advantage of the available digital transport data and use it for transport statistics purposes. This has the potential to make the data collection more efficient and therefore enable to update the data which the models relies on more often.

The mission of the TRANS-TOOLS 3 (TT3) project is to improve the methodological basis of the TRANS-TOOLS model, improve and validate its data foundation, deal with known deficiencies of the existing model, make the software more efficient, and focus on the user needs, model documentation and model validation (see www.transportmodel.eu/ for more information). Due to the current development within the TT3 project aiming at improving cross-border transport analysis, a general recommendation from the GreCOR project is not to develop a separate standard for data analysis and presentation as was one of the intended purposes of WP3, but to gain knowledge, synergies and use produced information from the TT3 project for transport analysis along cross border corridor.

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Appendix A





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