1. Final publishable summary

The TT3 project developed the third upgraded version of the European transport demand and network model, TRANSTOOLS. This report describes the main parts and functionality of the model as well as its objectives and the project's scientific contributions.

1.1 Executive summary

The objective of the TT3 project was to upgrade and further develop the current TRANSTOOLS model (TT2) to a new and improved European transport demand and network model (TT3).

This objective was achieved by the project which ran in the period: 01.03.2011 – 31.12.2016.

The project improved the methodological basis of TRANSTOOLS, improved and validated its data foundation, dealt with known deficiencies of the existing model, made the software faster and more efficient, and focused on the user needs, model documentation and model validation. The passenger demand models were re-estimated in order to include non-linear utility functions. A new freight and logistics model was developed and estimated on disaggregated data, and linked to a freight chain model. The passenger assignment methodologies were improved in order to save calculation time and reduce stochastic components.

In addition, the model updated the current TRANSTOOLS model - from 2005 as base year - to 2010 as base year, based upon ETISplus and other data sources including transport networks (all modes[1]), traffic counts, transport matrices (passengers, vehicles/coaches, freight (both in volumes and monetary values), zonal data (including socioeconomic data). In addition, the geographical coverage of the model was enlarged to include all of Europe (to the Urals and the Black Sea and including Turkey), and intercontinental sub-modules were added to describe intercontinental sea freight transport and air passenger transport

The level of detail with regard to the rail, maritime and air network transport modules was increased. This allows for better analysis of costs and externalities of transport. Finally, the impact assessment model was improved by making it consistent with the 2013 Reference Scenario[2] and the respective projections of the external costs.

In developing the model, special focus was placed on making the model more efficient with regard to calculation time, without compromising the scientific validity with regard to causal relationships and the description of transport behaviour.

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[1] Passenger modes: Air, road, rail, bus. Freight modes: Road, rail, inland waterways, short sea shipping.

[2] EU Energy, transport and GHG emissions - Trends To 2050 - Reference Scenario 2013
http://ec.europa.eu/transport/media/publications/doc/trends-to-2050-update-2013.pdf

The TT3 project has delivered a validated, well-documented and user-friendly model that provides policy makers with a tool for assessing and developing better transport policies.

TT3 has maintained the tool-box approach from prior versions of the model, which ensures that it can address the needs of many different types of users, for example analyses of EU-wise transport policies, analyses of TEN-projects and links to interregional and national project appraisals. The TT3 model is free, and more open than the previous model (while building on ArcGIS and Windows).

The TT3 project consortium consisted of 14 partners and was coordinated by DTU. For more information about the project, please consult the project web-site: http://www.transtools3.eu/

1.2 Summary description of project context and objectives

1.2.1 Background

The purpose of the European transport network model, TRANSTOOLS, is to provide policy makers with a tool for assessing and developing better transport policies.

TRANSTOOLS has been developed in several phases and builds on a mixture of prior European models and new sub-models. Initially, TRANSTOOLS was developed for DG TREN under the sixth framework programme (FP6). The current model, Transtools 3 (TT3), was developed for DG MOVE under the seventh framework programme (FP7).

In TRANSTOOLS1 (TT1) an open linkage between sub-models was designed using ArcGIS Model Builder. This allowed users to reconfigure the model flow without the need to reprogram the model user interface, for example by decoupling sub-models or using only some of the sub- models for specific scenarios. It also simplified the task of replacing sub-models. TT1 linked sub-models from prior EU projects, and new model components were developed. This was especially the case with regard to the traffic assignment models, which were made much more detailed than previously in order to model congestion (a core requirement in the call from DG TREN).

The application of ArcGIS enabled the use of all the editing and visualisation facilities that are embedded in a professional GIS (Geographical Information System). DG TREN, JRC IPTS and Eurostat also used ArcGIS, which was one reason for the choice of platform. Another reason was that, by using a standard GIS, the effort in model development could be directed towards the development of the traffic model itself, rather than on reinventing data editing and management facilities.

A core concept was the tool-box approach, which means that the linkage between sub-models is carried out in an open format that easily can be modified by (expert) users, in most cases even without any programming expertise. This helped the initial development of TT1 that built on different prior models, made it easy to replace some of these sub-models in TRANSTOOLS2 (TT2), and also made the further development feasible in TT3.

The TEN CONNECT project used the TT2 model to evaluate TEN projects (large corridors and projects) within the EU. In order to address identified problems in TT1, TEN CONNECT further developed the model. This included an update of the base year (to 2005), increasing the level of detail in the zone system, the development of a new passenger demand model (which runs at the NUTS3 level), and the development of an advanced multi-modal route choice model for the choice of air transport route, airport and feeder mode (rail versus car). A major innovation in the passenger demand and assignment models was the switch to a tour-based approach, where the model keeps track not only of each trip, but also of the zones that generated and attracted the trip. All trips can therefore directly be linked to the nationality of the person that carries out the trip (e.g. a Danish person travelling to Italy can be distinguished from an Italian person travelling home from Denmark). Moreover, the passenger model established a segmentation into short- and long trips, estimated the model on the basis of micro data, joint estimation of mode- and destination (full information maximum likelihood estimation), and introduced non-linear forms to cope with non-linear preferences in the distance domain.

TT2 also built on the ArcGIS as user interface because it had worked well in TT1, for the sake of continuity, and because the call required coordination with the ArcGIS based geo- databases in Eurostat.

The ambition for the TT3 model was to develop a new and improved version of TRANSTOOLS calibrated to the base year 2010. The new model was required to update the modules of the previous versions of TRANSTOOLS and incorporate improved data, networks and modelling techniques of other projects related to TRANSTOOLS (iTREN2030, ETISplus, LOGMAN, etc.).

1.3 Objectives

1.3.1 Objectives solved by the TT3 project

Even though TT2 was used for policy and project appraisals, a number of issues for improvement had been raised by users, reviewers and the model developers themselves. The TT3 model thus built on a significant base of experience and solved the problems and issues that had been raised.

Model objectives

The incremental development of the TT2 model meant that there was no single report that documented the model scientifically. As some of the core modules originate from before TT1, it was difficult for a new user to get an overall understanding of the model framework. The TT3 project therefore aimed at developing a thorough scientific documentation as well as a detailed user guide. As model implementation was separated from model development within the consortium, the documentation as regards software implementation mirrors the exact mathematical structure of all model components. This can also be seen as a “model-protocol” which makes it easy for external partners to establish model linkages to TT3.

Because the TT2 model was developed in a sequence of short projects, overall validations were not carried out until after the projects. The TT3 project aimed at including a validation phase in order to solve issues that were raised in the development of the model.

TT1 had been developed for detailed project appraisal and TT2 for appraisal of TEN corridors. This meant that the model was highly detailed geographically and that the standard version was configured to provide very detailed results at the network level. The long calculation time was a source of criticism.

Nonetheless, due to the modular approach and the configuration of (most) sub-models through parameter tables, it was fairly easy to change the model configuration (e.g., for fast policy appraisals with specific modes or sectors). As a result there was no need to reprogram the TT3 model to meet other purposes (as regards computing time and level of details), since different model configurations can be defined with the present model interface. In spite of this, previous experiences showed that only expert users manage to do this. For the TT3 model, there was a perceived need for predefined model configurations which were to be developed and tested in the project, as well as a need for restructuring the overall model logic in order to make it possible for users to be able to go beyond the standard configuration and harness the full flexibility of the model.

The trade model in TT2 did not depend directly upon any of the core network variables (level of service data) and it was unrealistically inelastic with respect to core policy variables. The TT3 project thus developed a new trade model.

The freight mode choice and logistics model (which includes mode chains) in TT2 ran at a NUTS2 level (which implies very large zones in some countries), whilst the rest of the model ran on NUTS3 (which implies much more detailed in most countries). This means that the model is inappropriate for the evaluation of freight related policies in countries with a small number of NUTS2 zones. A more methodological issue is that mode choice is described in the freight mode choice model as well as in the mode chain model being part of the logistics model. This leads to some inconsistencies. In addition, the linkage between the freight models and the rest of the model system had inconsistencies. An aim of the TT3 project was therefore to replace the freight and logistics models and to estimate the models on disaggregate data.

The base for the logistics model in TT2 stems from before TT1. The model is related to NUTS2 zones, whereby users cannot analyse policies with regard to specific multimodal terminals (e.g., harbours, rail yards). The model also had the problem that outputs changed quite significantly for some scenarios where the network data were only changed marginally. The way the alternatives were selected seems to be the reason for this, and this provides further explanation for our decision to replace the logistics model.

Experience with the present passenger demand model in TT2 has shown that the model tends to overestimate long distance rail transport. There are various reasons for this: 1) the base matrices seem to contain too many long rail trips, as too few counts have been available to re-estimate the matrices, 2) the passenger demand model structure indicate that separate functional forms for the utility functions for rail and other models should be addressed (the present model has non-linear utility functions but not with mode-specific parameters), 3) the joint estimation based on aggregate data (ETISplus) and disaggregate data (DATELINE) seems to contain some inconsistencies in data. However, we believe that it is difficult to estimate and identify functional forms and parameters based only on aggregate data (demand matrices from ETISplus). We therefore re-estimated the model based upon a combined estimation that uses other available relevant data sources.

Rail freight and passenger rail are modelled separately and on different network databases in TT2. This means that the rail network data must be maintained redundantly (for railways with both passenger and freight transport). The project merged the two networks into one database and developed the rail model to meet these criticisms.

In TT2, the air transport module is very detailed within Europe, since it models the type of carrier (low price versus conventional through the cost), air route, choice of departure and arrival airport and choice of access and egress mode. The model, however, does not model intercontinental air transport, which is a problem with regard to some policies and with regard to the modelling of feeder air traffic to the main airports (hubs). Intercontinental air transport was thus added to the TT3 model.

The sea transport is not assigned onto the network (sea transport) in TT2. The model thus just builds on shortest sailing distance as input and demand matrices as output. Transport beyond Europe is not modelled explicitly in a transparent way, although there is some modelling of trade within the economic model and port zones in the freight models. To deal with these issues, explicit modelling of sea was added to the TT3 model.

A new improved set of impact assessment models was developed and linked to the rest of the TT3 model. The primary differences are that the evolution of unit external costs is now consistent with the 2013 Reference Scenario.

It is somewhat difficult for non-expert users to define consistent scenarios with TT2 since many variables and parameters are related. To address this, we developed a “scenario generator” as well as a guideline on how to work with scenarios.

Data objectives

The zone structure was revised and sub-zones were created in countries where zones were (far) too large. An example was Spain and several metropolitan regions of Europe (e.g., London).

Existing disaggregated data from national sources was identified and included for the estimation of the logistics model.

ETISplus provided aggregated data (e.g. matrices): freight matrices at NUTS2 level and synthetic passenger matrices. In order to estimate the models, this information was combined with disaggregate data and meta-data (such as data from national value of time studies) in order to identify and estimate the demand models.

Base trip matrices for road transport were adjusted in order to fit with the available traffic counts (mainly provided by ETISplus). Air matrices were adjusted to match air transport statistics.

Software and user objectives

The TT2 model builds upon the Traffic Analyst (TA) software for traffic assignment. The software is easily configurable, since (expert) users can change parameters, utility functions, stochastic distributions (i.e., type of distribution, correlation structure and parameters), number of trip purposes, solution algorithm, etc. This fulfils most expert users' needs for model modifications. However, in order to make the assignment models more flexible, the TT3 project "opened up" the code of the scientific part of the software, which means that programmers can modify (or replace) more core algorithms in the software. In essence, these parts of the software are open source. Users can see the standard code for e.g. the configurable utility function, make a change to this code, compile a new binary module with just this function, and instruct the system to use this module in place of the standard function. Another criticism to TT2 was that TA is commercial software with a licence. TT3 on the contrary provide a free compiled TA version of the software components that are used in TT3.

3) There were some concerns about the openness of the TT2 model since some model components are not open source. In particular, the trade model, the economic model, and the freight model have been criticised for having some parameters and variables hard coded. The new trade, freight and logistics models, and the impact assessment models were recoded to provide open access to parameters and model flow. This means that the TT3 model is open and free, with the only limitations as mentioned in point 2 above.

4) The TT3 project focused on developing a better user guide and improving the model interface in order to ease the use of the model for future users.

Performance of the model

One of the most criticized aspects of TT2 was the long computation time. However, we did not believe that the solution lies in the simplification of the methods (causal relationships in the model). For example, the model applies different values-of-time and willingness-to-pay attributes among countries and trip purposes, and the network models also apply value of time distributions (stochastic assignment). This allows for different road users to react differently to, for example, road user charging. The persons with high value of times will gain time due to less congestion, and accordingly will be willing to pay the charging. They may even increase travelling due to lower congestion. By contrast, the persons with low values of time reduce travelling. Overlooking these aspects would affect the results – also at a European level of policy analyses – and one might also overlook equity issues within and between member states. One may easily imagine that some member states or political parties would object if such core issues were ignored.

Another approach to reduce computational time is to use fewer iterations in the model and simpler solution algorithms. However, even though this may result in simple robust computational outputs for a base scenario, it might produce strange results in computing scenarios. This might increase the risk that the stochasticity of the assignment algorithm will bias consumer surplus measures, as was the lesson from TT2. In order to reduce computational time the project therefore used the following alternative strategy:

1) Development of more efficient solution algorithms. Examples are the use of matrix thinning and replacement of the assignment method.

2) Configuring the model for standard setups, where only a sub-part of the model system is run for specific policy analyses.

1.4 Description of main Scientific and Technical results/foregrounds

The modelling scope of TT3, with 42 European countries and additional world zones outside Europe, is one of the largest modelling scopes for a transport model. This gave rise to numerous technical as well as practical challenges which were resolved during the project in the best possible way. In the following section we describe the scientific and technical achievements of the project by focusing on the freight models, the passenger demand models, the traffic assignment models (network models) and also the software platform in which the model is integrated. As a start, we present the overall model structure and the scope of the model.

Overall model scope

The model-scope is best illustrated with a series of key statistics as presented below.

Table 1-1: Summary statistics of the TT3 scope. Numbers are only for EU27 and between EU27 countries.

Type	Value
Number of countries	42
Number of zones	1525 (+ 67 world zones)
Population	810,044,825 (+ 6,156,181,085)
Road network: KM network / Number of links	548,558 km / 52,846 links
Rail network: KM network / Number of links	278,724 km / 9,948 links
IWW network: KM network / Number of links	22,101 km / 1,109 links
Sea network: KM network / Number of links	144,776,696 km / 36,684 links
Aviation network: KM network / Number of links	16,002,118 km / 7,691 links
Number of passenger modes/ trip purposes	Business, Private, Commute
Number of freight modes	Sea wessels (8 different container ship sizes, 7 dry bulk ship sizes, 4 liquid bulk ship sizes), IWW wessels (6 CEMT classes), train, Vans, Trucks, Giga-liners (Trucks)
Main freight types	Dry bulk, liquid bulk, general cargo, container
Number of commodity groups	11
Number of freight chain-types	9
Number of airports	1,255
Number of train stations	8,597
Number of freight terminals	Total: 1,023; Rail: 631; IWW: 175; Sea: 452

The geographical area covered by the model is very large and the average size of zones is large. Moreover, there is a very different resolution level of zones from country to country. The previous TT models had even more extreme variations and there has been significant work in making the size of zones more homogenous. However, there are still substantial differences. Figure 1-1 below shows the zones with their respective populations.

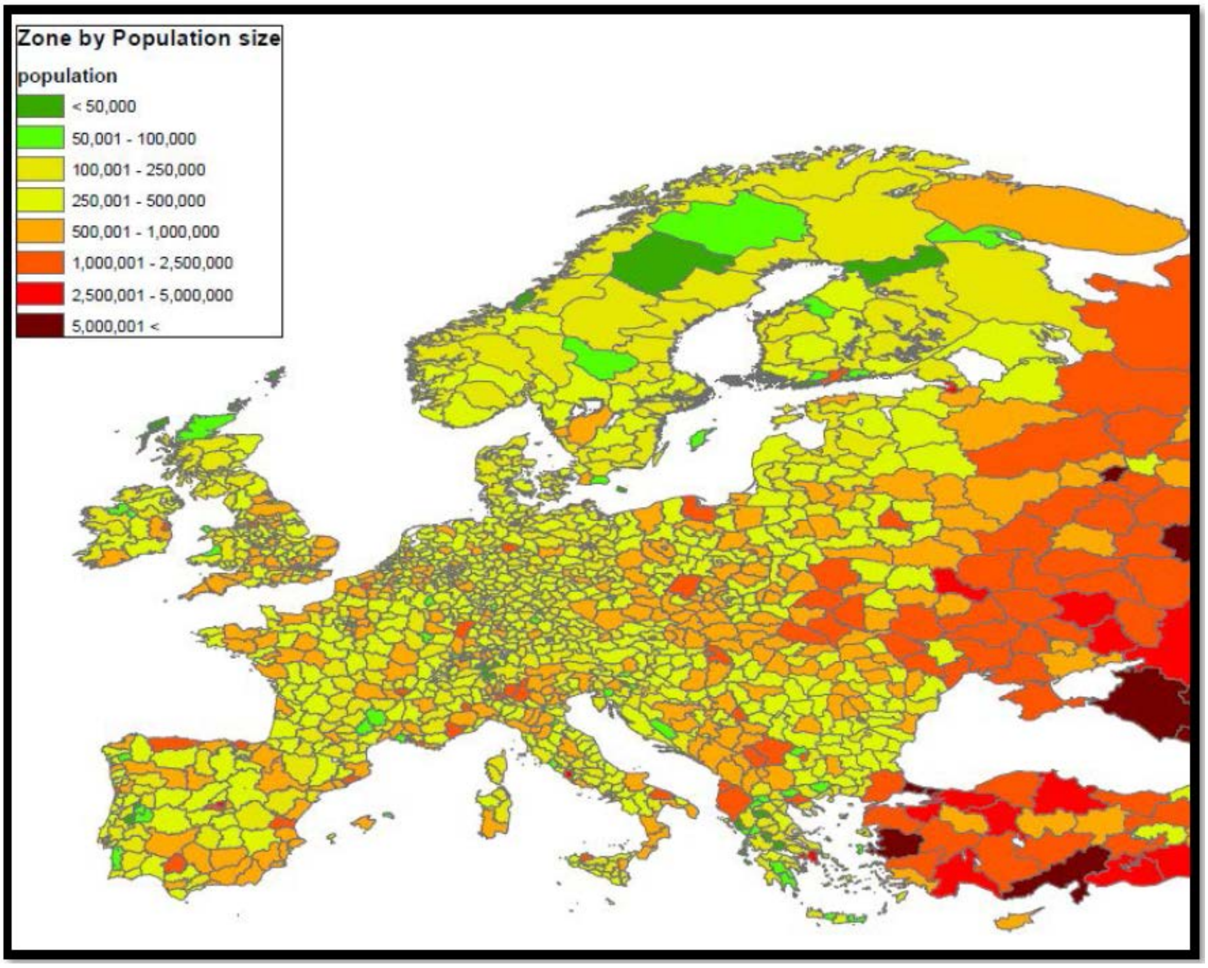

Figure 1-1: Zones and population in the model system

As can be seen, there are relatively small zones in Germany and Benelux countries, whereas Spain, France and the Scandinavian countries have larger zones. For Eastern European countries outside EU, zones are typically much larger and the extreme cases are Russia and Turkey.

The TT3 model system consists of several sub-models of which the following are the most important:

- Passenger demand model
- Freight demand model
- Assignment models (network models)

Figure 1-2 illustrates the overall structure of the TT3 model system and shows how the different sub-models are linked. The demand model is divided into a passenger model and a freight model. Each of these models provides demand in the form of matrices which are then input to the assignment model from which level of service (LoS) variables are calculated and used as new input to the demand models in the next iteration. From this process, the final origin-destination matrix is obtained together with the final equilibrated LoS. These are then used in potential impact assessment modelling.

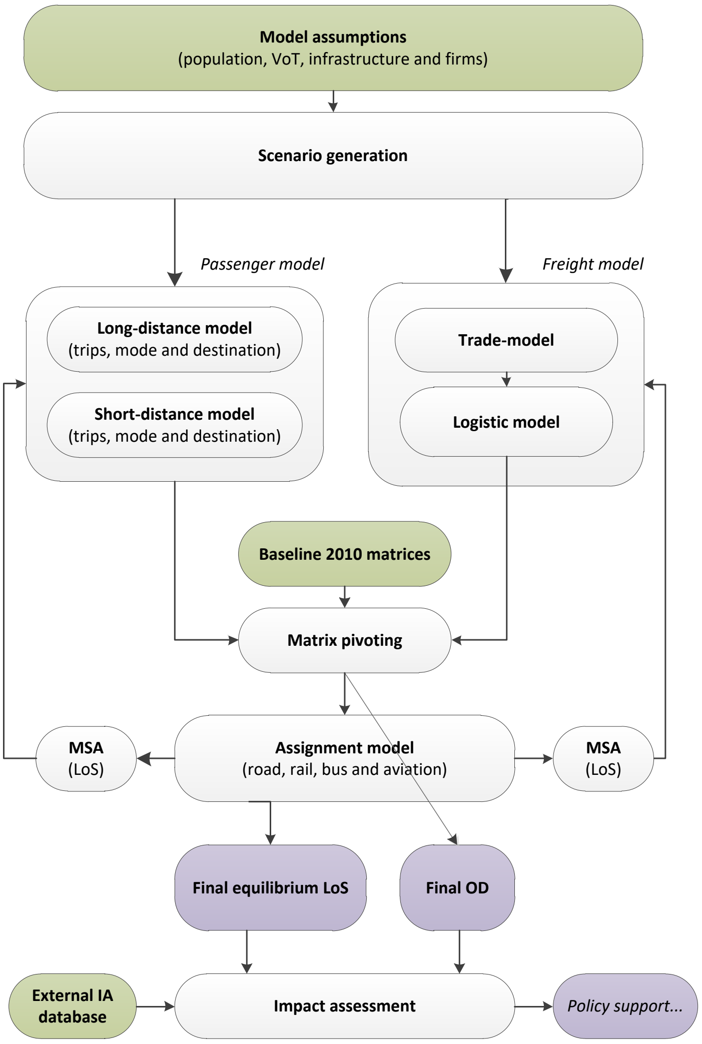

Figure 1-2: Structure of the Transtools 3 model system.

Below we will describe the different model components in more detail.

1.4.1 The passenger model

The short tour model

The passenger model consists of two main segments: firstly, a model for short tours below 100 Km (or within zones) and secondly, a model for the remaining long tours.

For short tours, a nested logit model specification was defined and estimated. The model included the following choices:

- Destination zone
- Intrazonal (within zones) and Interzonal (between zones) tour
- Mode
- Tour and No-tour

The following modes were included:

- Walk
- Tram/Metro
- Bike
- Rail
- Car as driver
- Bus
- Car as passenger

Purpose specific model were estimated for the following travel purposes:

- Business tours
- Private and Vacation tours
- Commuting tours

The following variable types were included:

- Alternative-specific constants
- Intrazonal mode-specific radius (reflecting a zone size depending on intrazonal distance)
- Generalised time (time components and costs converted to time using a zone specific value of time) for car and rail
- Mode-specific distance variables for modes not having explicit level of service data
- Mode-specific dummy variables for tours with destination in another country
- Size variables for destination zones
- Socioeconomic variables for tour origin zone

The models were estimated on ETISplus data concerning demand, destination zones and socioeconomic data. For the estimation of the model LoS data from the TT2.5 project was used.

The short-distance tour model suffers from the much aggregated zone system and cannot realistically be applied for detailed policy analysis as it is not capable of dealing with congestion and bike and walk trips. In essence, the demand data is completely dominated by intrazonal tours (98 percent of all tours). This fact has motivated the separate level for the choice between intrazonal and interzonal tours which allows substitution between intrazonal and interzonal tours. The data is heterogeneous in terms of zone size definitions. This has an impact specifically on short tours as nine countries account for 90 percent of all OD pairs. As the corresponding models always reflect the underlying data it is clear that these specific countries will play a dominant role in the estimation and could have impacted on the estimated parameters. Another issue is that the TT2.5 LoS data refers to the base year 2005. Although we have adjusted prices to the 2010 price level it has been necessary to assume that other changes in the LoS between 2005 and 2010 can be neglected.

Each of the estimated models contains most of the variables listed above. In all cases, the structural parameter from the lowest level (destination choice) was found to be low, implying a low rate of substitution between intrazonal and interzonal tours. This is, we believe, due to the dominance of intrazonal tours in the choice process. It was not possible to identify a structural parameter different from one from the intrazonal/interzonal choice level in all cases.

The resulting elasticities related to policy variables such as travel cost and travel time are generally low. It should however be kept in mind that elasticities may vary quite substantially depending on the context (market shares and variable values). The low logsum parameter from the destination choice level for all travel purposes creates “inertia” between interzonal and intrazonal travel in the sense that the substitution is low, and this is reflected in low elasticities. However, this does not necessarily mean that substitution effects will be low in absolute volumes, because of the dominating intrazonal demand. If only interzonal tours are considered, elasticities are largely compatible with elasticities reported for EU countries.

It should be noted that the models do not, as would be preferable, reflect behaviour collected at the individual level. Rather the model reflects a modelling effort based on a variety of data sources, which mostly refer to a matrix level and to some extent ETISplus matrices. In line with this, the models will largely reproduce behaviour as reflected in the ETISplus matrices. Hence, there is the danger that the short distance models are just the reproduction of another model rather than being a reflection of actual behaviour. This is clearly not ideal but as no additional and newer data has been available this has been the best option. The result of the short tours modelling effort is a set of purpose-specific models for Business, Private + Vacation and Commute tours using a parsimonious specification that we believe will provide a robust forecasting tool.

From a technical perspective the models will render GA matrices, which will be translated to OD matrices. The OD matrices will then be pivoted around a 2010 baseline, which will ensure that we replicate the baseline in 2010.

The long tour model

The long-tour models represent all tours above 100 KM and represent models for the choice of mode, destination and frequency. These models have been validated against observed micro data and results are encouraging despite being based on DATELINE[3] data which is from 2001/2002. During the model development several model specifications were estimated. It was tested whether it was possible to estimate the value-of-time directly or whether it was better to superimpose a fixed value-of-time prior

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[3] DG-TREN (2000). DATELINE – Design and Application of a Travel Survey for European Long-Distance Trips Based on an International Network of Expertise, Project: 2000-AM.10016,http://research.ncl.ac.uk/dateline/ (last access: February 2010).

to estimation. In the final estimation stages it was decided to use a fixed value-of-time with estimates based on Wardman et. al. (2013). This model was chosen due to concerns about robustness.

An important issue has been to take account of non-linearity in the distance domain. The motivation is based on knowledge from the Swedish and Danish National model as well as previous versions of TransTools. If non-linearities are not properly accounted for, there will be consequences for elasticities, which due to scaling-effects will be too high. Identification of non-linear distance functions is particular relevant in a long distance model covering the whole of Europe. In the estimated models, non-linear forms turned out to be significant for all models.

A fundamental problem for the model estimation was the lack of new micro data. Hence, it was decided to apply the existing European travel survey, DATELINE, from 2001/2002, which was also applied in the estimation of the previous model. This has given rise to several challenges. First, there is no income data. Second, it lacks information about travel behaviour from a number of Eastern Europe countries. Third, the time of the data collection (2001/2002) is inconsistent as regards the infrastructure and the transport pattern across Europe. As an example, there was a subsequent boom in the aviation industry. while the high-speed rail infrastructure was much less developed compared to 2010. This is likely to have some implications for the model parameters and the resulting policy scenarios generated by the model.

Despite challenges with respect to data, the long distance models fulfil the main objectives initially agreed upon. The estimation techniques that we considered as most appropriate turned out to provide reasonable as well as logical results when validated. In the estimation we used the full set of data and did not use sampling of alternative in the choice models.

Compared to the previous TransTools 2 model the new passenger model differs in; i) having a more flexible functional forms, ii) better validation of distance profiles, iii) changed and updated value-of-time estimates, iv) introduction of segmentation based on duration, and v) a re-design of the short-distance model.

1.4.2 The freight model

The freight model in TT3 represents a major step forward compared to the previous model as TT2 did not have a fully functioning embedded freight model. Moreover, whereas passenger models tend to be uncertain when applied to a very coarse zone structure, freight models makes more sense at this aggregate level and should provide a basis for valuable policy analysis for Europe. The Transtools 3 freight model is a state-of-the-art freight model which contains the following model components:

1. An international and interregional trade model to deliver zone-to-zone production-consumption (PC) matrices in Euros
2. A conversion from zone-to-zone in Euros to more disaggregate flows in tonnes.
3. Single modal route choice models to generate transport cost and times, and chain route choice models to calculate overall cost and times for a number of multimodal transport chain types.
4. A disaggregate model for mode choice and other logistics choices (shipment size, number of legs in the transport chain, transhipment locations, limited vehicle type choice).

5. Aggregation to zone-to-zone OD flows (tonnes)
6. Chain route choice and network loading (assignment of tonnes)
7. Conversion of flows from tonnes to vessels
8. Pivot-point procedure to pivot predicted OD flow changes on a base OD matrix.
9. Unimodal Assignment of flows onto the networks).

This makes the model structure largely consistent with the aggregate-disaggregate-aggregate (ADA) national freight models of Norway and Sweden (see de Jong and Ben-Akiva, 2007), the freight model developed for the Mobility Masterplan Flanders (de Jong et al., 2010) and the Danish national freight model (Hansen, 2015). However, it adds a more detailed modelling of multi-modal chains. The ADA model structure is shown in Figure 1-3, below, where the top level displays the aggregate models and the disaggregate models are at the bottom level:

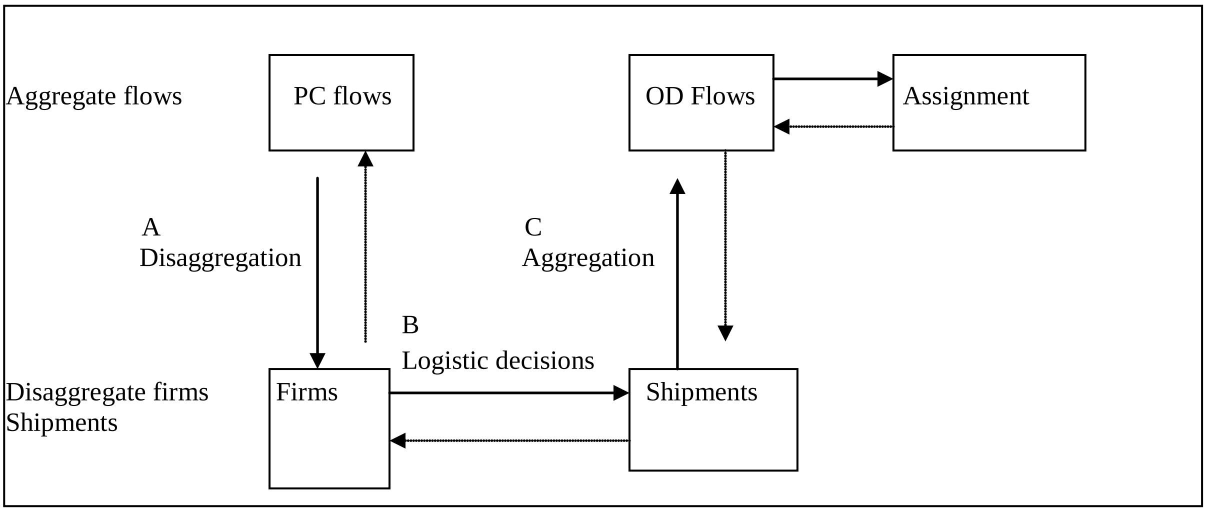

Figure 1-3: The Aggregate-Disaggregate-Aggregate (ADA) model; source: Ben-Akiva and de Jong (2013)

The solid arrows indicate the data flows that are needed for the consecutive steps in the operation of the model system. The dashed arrows give a feedback effect of level-of-service variables on transport demand.

The key characteristic that distinguishes these ADA models (and a handful of other transport models using different approaches; see for instance Tavasszy et al., 1998; Hunt et al., 2001; Jin et al., 2005; Liedtke, 2009; Friedrich, 2010; Roorda et al., 2010; Samimi et al., 2010) from conventional freight transport models is the inclusion of logistics choices, such as shipment size and transport chains.

The development of the new Transtools freight model was motivated by updated data from ETISplus (2014) and deficiencies in the existing Transtools 2 freight model. Specific data sources for estimation of the components of the freight model were identified and obtained during the project (notable the micro data from the French ECHO survey and the Swedish Commodity Flow Survey 2009 that are needed for estimation of the logistics model; also inputs from ETISplus, 2014). Below in Figure 1-4 the overall model structure of the freight model is shown.

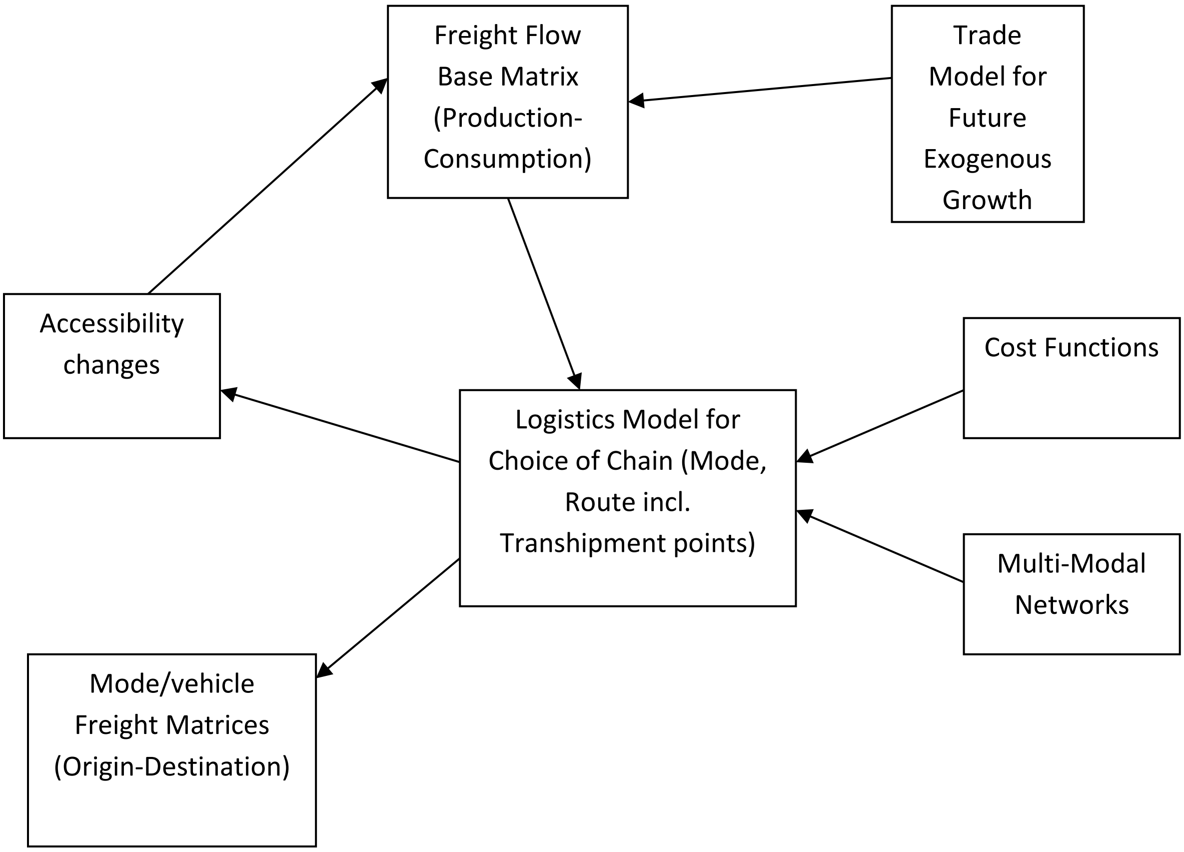

Figure 1-4: Structure of the Transtools 3 freight transport model.

Estimation of trade models (WP7.2) explaining the transport flows between NUTS3 zones (by NST/R 1 commodity type), was based on the gravity formulation from characteristics of the zones and their spatial separation or transport resistance between them. The dependent variables for this were the flows according to the ETISplus production-consumption matrix for 2010. Explanatory variables were partly derived from ETISplus and partly from publicly available sources.

The trade model

The trade model was developed to estimate trade flows between different origin and destination zones or trade flows within such zones. In the trade flow model, trade flows are measured in tonnes, not in monetary values, so strictly speaking, these flows might be called transport flows between production and consumption locations (PC flows) and the model a PC model.

The key variables to explain trade flows are the distance between the zones, the population and GDP of the origin and destination zones, and whether the zones are within the same country or in neighbourhood countries. Further variables are whether trading zones share the same language, whether both zones are within the EU or EFTA region, and whether both countries share the same currency.

We used data on traffic flows between so-called EZ2006_3 zones. These zones are specific to this project and in 70% of the cases identical to NUTS-3 zones[4]. In the other cases they cover two or more NUTS-3 zones. There is information on ten different types of goods defined by the NST-R level 1 classification. We performed analysis on each of these ten different types of goods.

Since we did not have data over time, our trade flow models, which are basically of the gravity-type, have to be regarded as descriptive rather than explanatory: the coefficients do not necessarily reflect causalities and provide a rather stylised model of the link between GDP and trade. It is important to take into account the limitations and potential biases of this model and we recommend backing up forecast values by alternative models.

The basis of our data is a production-consumption matrix (PC matrix) for ETISplus level 3 (EZ2006_3) zones. In the following we refer to this as the ETIS-3 zones. Each observation covers the flow of a specific type of goods following the NST-R level 2 (NSTR-2) classifications from an origin zone to a destination zone. This flow data was produced in the ETISplus project (2014). They used a PC matrix of observed data at country level and then imputed trade flows for each individual pair of zones using methods that take into account the GDP and other variables of the ETIS-3 zones. We used this PC matrix as given, as an expert-based input to the estimation. We know it was only observed at the country level, but for the detailed zonal level that TT3 needs, this is the best EU-wide PC matrix that was available to us. As a check, we have also estimated the models on data at the country level, so that we could compare the results with those at the detailed spatial level.

Unfortunately, there are many missing observations in the P/C matrix and a key problem is how to interpret these missing data. To deal with this problem, we decided to exclude missing observations from the estimation since we use the standard log specification of the gravity model. Justification for this choice was made in D7.2 and it led to the choice of a model which did not apply the Heckmann correction as we did not have sufficient data to support this model type.

One way to reduce the problem of observations of goods flows being zero is to use aggregated goods categories. In our case, we aggregated the corresponding NSTR level 2 goods to NSTR level 1 goods. As a specific case, the proportion of positive goods flows between zones increases from 6.6% to 29% in the case of NSTR level 1 goods category zero. We also aggregated the data to country level such that both origins and destinations are at country level.

The goods type labels were created by use of the table Eurostat RAMON (Reference and Management of Nomenclatures) NST 2007 - NST/R 1967 table.[5] The NSTR code was interpreted so that the first two digits correspond to the variable NSTR2. The aggregation to the NST-R level 1 classification was done such that all tonne values were aggregated following the first digit of NSTR.[6]

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[4] The abbreviation "NUTS" stands for Nomenclature of Units for Territorial Statistics is a geocode standard for referencing the subdivisions of countries for statistical purposes. The standard is developed and regulated by the European Union, and thus only covers the member states of the EU in detail.

[5] Source: http://ec.europa.eu/eurostat/ramon/relations/index.cfm?TargetUrl=LST_REL&StrLanguageCode=EN&IntCurrentPage=8.

[6] The NSTR level 2 2-digit code was transformed as follows: NSTR1 = truncate(NSTR2/10). Then all tonnes with the same NSTR1 code were summed up. Note that above NST2 stands for the NST-R level 2 classification code (2 digits) and NST2

The connection between the trade-model and the logistics model is through logsum variables, which feed accessibility effects to the trade model from the logistics model. Hence, whenever there is a change in transportation costs this will lead to a change in logsums, which in turn will lead to a change in the trade-flows.

The chain choice model

The model for the choice between mode and other logistics choices such as shipment size is a joint model (in contrast to the current Transtools 2 model) segmented by commodity group. The two choice problems are thus modelled in a common framework in order for the model to be consistent with the principles of utility maximisation or, conversely, cost minimisation. For bulk commodity groups, however, only mode (or transport chain) is applied, as in the current Transtools 2 model. For all other combinations, the model explains the choice of transport chain including the mode used for each leg of the transport chain.

Whereas the trade models yield freight tonne matrices between the zone of production and the zone of consumption by commodity group, the logistics model operates at the level of firm-to-firm (F2F) flows. More specifically, this involves operations between firms in the sending zone and firms in the receiving zone.

Both the national freight models in Norway and Sweden use a zone system based on municipalities. Since the zone sizes used in Transtools 3 are significantly larger, the disaggregation into F2F-flows is even more important because, in reality, large zone-to-zone flows are not subject to the same logistics chaining as small flows.

Without disaggregation to F2F-flows, the modelling would allocate too much freight for large shipments between distribution centres.

However, as the potential F2F combinations are very large when applied to the whole of Europe, an alternative allocation according to shipment size bands (categories based on the size of the shipment) has been applied.

The locations of transport distribution centres (DC) are considered as exogenously given (in contrast to the current TT2 model). There are, in fact, considerable problems in letting the model determine DC locations. Firstly, it is almost impossible to mimic the actual location behaviour, which as a minimum would require solving a complex non-linear location problem. If the solution then is to allocate DCs endogenously, this would call for heuristic principles in the location of DCs (as in the current TT2 model). Secondly, the model would not be able to calculate the impact of scenarios that include the implementation of new DCs. Thirdly, the approach implicitly assumes that all zones have DCs (since

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stands for the NST-R level 1 classification code (1 digit). Table 1 contains all goods type labels from the Eurostat RAMON (Reference And Management Of Nomenclatures) NST 2007 - NST/R 1967 table. The ";"-signs denote that the labels belong to different NST-R level 2 classification codes. We used the labels following the column "NSTR Label". The sources of the labels for the are from these publications: Source for the NST-R level 2 classification labels are the following: http://sites-final.uclouvain.be/econ/Logistique/NOMENCLATURES/PRODUITS/nst.html, , http://uclouvain.be or http://www.uni-mannheim.de/edz/pdf/statinf/09/KS-SF-09-042-EN.pdf.

they are not coded in the model). As the size of the zones is very different, this would introduce severe aggregation bias.

Results produced by the mode and logistics model are aggregated to mode and commodity specific flows between zones to be pivoted against the base year freight OD matrices. This is carried out to apply and utilize the information from the calibrated base year flows and hence improve the accuracy of prediction.

The key input data needed for the model for application is listed below.

- Base year matrices at the OD level (by mode) for the pivot point procedure.
- Number of firms, turnover and/or employment by zone for the disaggregation step.
- Forecasts of the exogenous variables in the trade and logistics models for future years (in the form of scenarios) at the zonal level.
- Expansion/correction factors at the zonal level for application of the disaggregate logistics models at the zonal level across Europe.

1.4.3 The assignment models

The overall purpose of the assignment models is to distribute the demand for passenger travel and the movement of goods onto the networks representing the different modes of travel. This yields the flow and also the congestion level on specific parts (links) of the network, and also produces Level-of-Service for different travel choices, which can then be fed back to the demand models for freight and passenger travel. Ultimately, equilibrium between the demand models and the assignment models should be obtained, corresponding to the situation in which the demand, when loaded onto the network, gives rise to a Level-of-Service corresponding to the Level-of-Service from which the demand was derived.

The assignment models distribute the flow on the network in a realistic manner that is consistent with the underlying behavioural assumptions. Such assumptions vary significantly between freight and passenger transport, leading to the need to apply different model frameworks. For freight transport, the TransTools3 assignment models assume a high level of network knowledge when assigning goods on the Sea, Inland Waterways and Rail networks. For passenger transport, travellers may to a higher degree have individual preferences and may not have as high knowledge about network performance (e.g. under its congested state). This requires a different modelling approach, and for this the TransTools3 utilises a recently proposed route choice model and associated solution algorithms, which have been shown to be theoretically consistent and which facilitate very fast computation, obviating the need for simulation.

The assignment models have different parameters in the cost-functions used to determine how large a proportion of the travellers each route should be associated with. These and other variables of the models need to be calibrated to give a realistic distribution across routes and realistic flows on the different parts (links) of the network. For this task there are several data sources available from the ETISplus project that are used, e.g. link counts of flow.

Overall structure

The TransTools3 model is divided into a freight model and a passenger model. For the freight model initial assignments are run to compute level-of service results that can be fed to the chain choice model which is the core of the freight model. Each of the different freight networks thus has an initial individual assignment. These are described in more detail in D9.2. The freight networks are:

- Road Freight network
- Rail freight network
- Sea network
- Inland waterways network
- RoRo network

The TransTools3 passenger model is assigned to 3 separate networks:

- Air Network
- Rail passenger network
- Road passenger network

There is also passenger transportation by sea (ferries and passenger ships), but these are integrated into the rail and road passenger networks where relevant. Furthermore, in order to capture road congestion effects realistically, road freight and road passengers are assigned simultaneously.

The assignment models play a paramount role in the overall TT3 model framework. Figure 1-5 illustrates in greater detail than Figure 1-2 the parts of the overall model framework which relates to the assignment model.

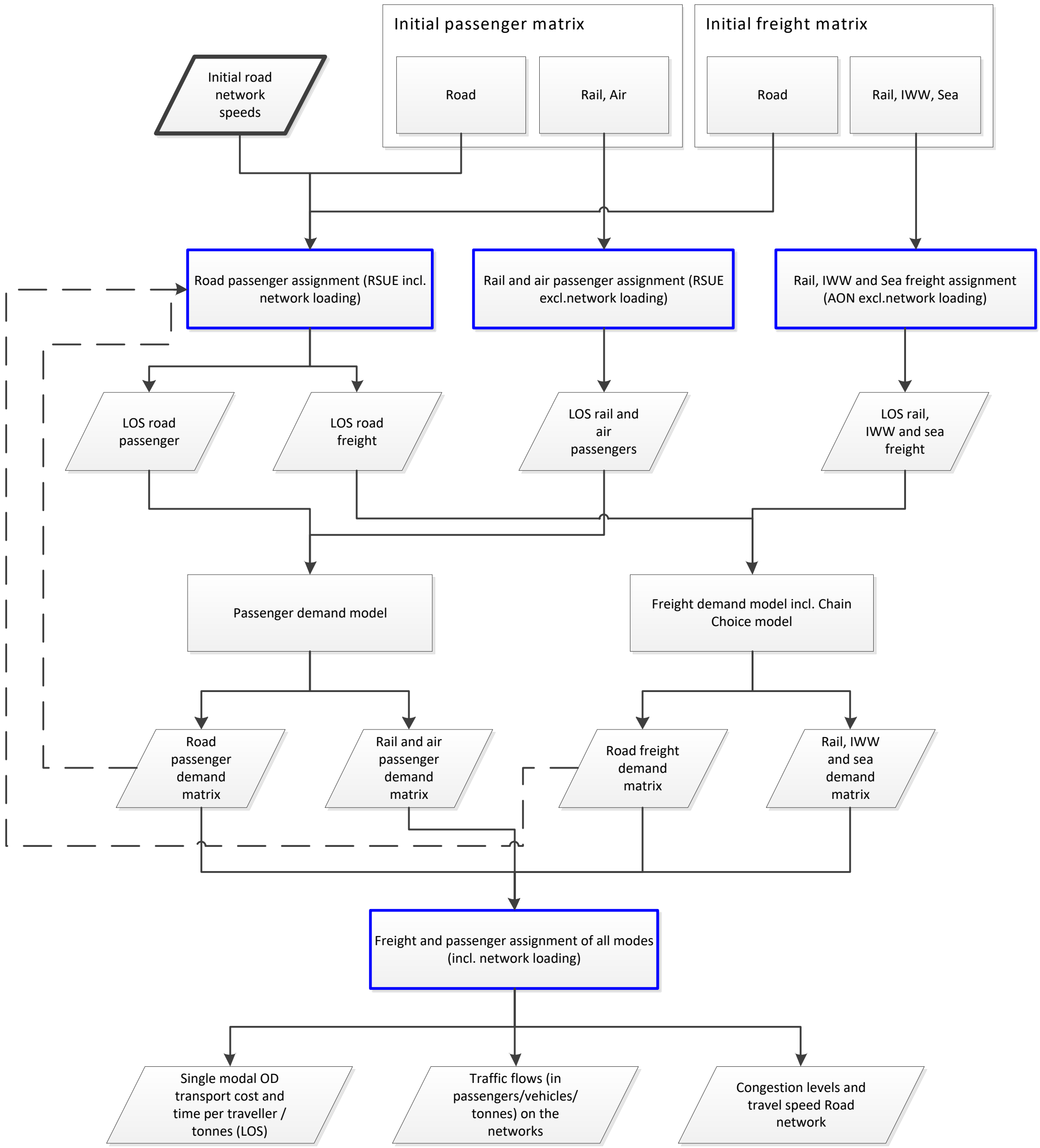

Figure 1-5: Overall model flow with focus on role of modal traffic assignment models

In the figure, the assignment models are highlighted in blue. Since congestion is only modelled for road transport, the other modes only need to be assigned twice – once when generating the initial LoS to be used in the demand models, and once when the final demand has been determined (in order to generate traffic flows). The LoS for road passengers and freight depend on the congestion level (i.e. the demand) and the demand depends on the LoS. This means that an iterative approach is needed; ensuring that the LoS derived from assigning demand induces the same demand level. Hence the road assignment model needs to run multiple times, as illustrated in the figure. Note that the model flow requires travel times on the road network as input for the initial assignment. This could e.g. stem from assigning an a priori given OD matrix

Methodological framework

The assignment models for the different modes for freight and passengers are based on different methodological frameworks. Moreover, considering the characteristics of the modes and the available network data (e.g. whether the possibility to model congestion implicitly exists), the best suited methodological approach is used.

On the passenger side, a wide array of personal trips has to be assigned. While the demand is split by mode of transport as well as into some categories by trip purpose, individuals within each of these groups may have their own preferences. Individuals may have different willingness to pay, for example whether to use an expensive bridge to save time versus a detour, whether to use a low-cost airline from an inconvenient airport versus a conventional airline from a nearer airport, whether to use a more expensive high speed rail connection or a cheaper slower alternative. Such taste heterogeneity should be reflected in the assignment models. The traditional approach towards incorporating this has been to use the Stochastic User Equilibrium Model (SUE, Daganzo and Sheffi, 1985) as the underlying behavioural framework. However, this framework suffers from a theoretical need to enumerate the universal set of alternatives (Watling et al., 2015). Full enumeration of the complete choice set is not feasible for most real-life applications, and certainly not for applications with the scope of Transtools3. This issue of choice set generation is often dealt with in large-scale applications by only using a subset of the universal set of alternatives, thereby compromising the theoretical consistency. Furthermore, the generation of the subset is not trivial, and the solution of SUE problems often requires simulation. Simulation is however computationally expensive and introduces stochasticity to the outputs.

Instead, the assignment of passengers to the different modal networks uses the recently developed Restricted Stochastic User Equilibrium model (see Watling et al., 2015). The overall advantage of this model consists in its ability to combine the possibility of having unused routes with the use of state-of-the-art random utility models for used routes in a theoretically consistent manner. Corresponding solution methods have been proposed in Rasmussen et al. (2015), while Rasmussen et al. (2016) verified the behavioural realism of the framework and the computational attractiveness of the solution methods for a large-scale case study.

For the rail and air networks congestion is not modelled directly (albeit captured in the edge travel times) in the assignment. Thus, for these networks the algorithm is run in a setting where it captures taste-heterogeneity by introducing ‘pseudo-categories’ through distributed parameters for each trip purpose, but it does not iterate to find the equilibrated network congestion. The ‘pseudo-categories’ are not generated by simulation, but by splitting the cumulative density function of the distributed parameters into intervals of even ‘probability’-share, and a ‘pseudo-category’ is created for the mean-parameter value of each interval (i.e. 3 intervals induces three ‘pseudo-categories’). For each ‘pseudo-category’, path searches are done using the corresponding cost-function and the flow associated with the ‘pseudo-category’ (total demand divided by the number of intervals) is distributed according to the choice model using the cost-function corresponding to the ‘pseudo-category’.

Congestion is modelled in the assignment to the road network, and the algorithm described in Rasmussen et al. (2015) is thus run with ‘pseudo-categories’ to represent taste heterogeneity, with a sufficient amount of iterations to ensure convergence to an equilibrated solution where the demand for travel reflects the (congested) performance of the network. The convergence is measured using a consistent measure, as introduced in Rasmussen et al. (2015). In order to capture the impact on congestion (and thus flow allocation), the road assignment is run with both the freight demand for lorries and the demand for passenger travel.

On the freight side, full transparency and rational behaviour of the shippers is assumed for Sea, IWW and Rail. This causes all demand of a certain commodity type to be allocated to only one route per OD-pair, i.e. an All-or-Nothing assignment to the cheapest route. For lorries, an assumption of full transparency and rational behaviour is less realistic. In road networks many more alternatives are typically available, and the lorry drivers may not know all of them or be able to predict the costs on the network. Furthermore, the lorries drive on roads which they share with cars and vans, and the drivers of these may not have full knowledge either. The lorries are thus assigned using the RSUE model framework in an assignment which considers congestion effects and lorry trips stemming from the freight model as well as passenger trips stemming from the passenger model (as argued above).

1.5 Potential impact and main dissemination activities

The development of the TT3 model has led to a number of impacts connected to;

- The application of the model to understand future challenges of European transport policy
- The derived political benefits from having a common model framework which can be applied to benchmarking of European infrastructure projects
- Research spinoffs which have led to high-ranked scientific papers and which will support the strong and ongoing European research community in the area of transport modelling
- Research collaboration across Europe and between consultancies, universities and public organisations, including using the model as case for research
- Possible use of the model in graduate studies and by PhD-students
- Practical spinoff in that the methodology and the data foundation established in TT3 is applied in other contexts, e.g. such as national models in different countries.
- Knowledge transfers from practical application of large scale models to the education of transport modellers at universities.

Dissemination of model deliverables

The TT3 model is a well-documented large-scale European model. Moreover, the model has been professionally coded and is embedded in a user-interface which allows users to manipulate scenarios and prepare model runs from a simple Windows-based software shell. Below we present the complete list of deliverables including the user manual.

Table 1-2: Complete list of deliverables in the TT3 project.

Reference	Deliverable Title	WP No.	Lead beneficiary number	Dissemination level
D2.1	Project web page	2	13	PU
D2.2	Web news letter	2	13	PU
D3.1	Guideline for model configurations	3	1	CO
D5.1	Note with specifications for ETIS+	5	1	RE
D3.2	User interface design documentation	3	4	PU
D5.2	Data description document	5	1	PU
D7.1	Draft report on the freight and logistics models	7	2	PU
D8.1	Draft report on the passenger demand model	8	3	PU
D9.1	Draft documentation of the assignment models	9	1	PU
D3.3	Model configurations (implementation and documentation)	3	4	PU
D10.1	Final methodological description of assessment model	10	1	PU
D3.4	Final date structure documentation	3	4	PU
D6.1	A report on scenario generation and software (including documentation for scenario generation)	6	2	PU
D8.2	Final report on the passenger demand model	8	3	PU
D9.2	Final documentation of the assignment models	9	1	PU
D7.2	Final report on the freight and logistics model	7	2	PU
D4.1	A technical documentation of the model structure and operation	4	4	PU
D2.3	Scientific documentation report	2	1	PU
D12.2	Installation at DGMOVE	12	4	PU
D12.3	User guide	12	4	PU
D11.1	Model validation	11	1	PU
D12.1	Deployment CD/DVD	12	4	PU

Some of these deliverables have been used for dissemination through the model development phase and as reporting for DGMOVE. The table below describes the main deliverables with relevance for new users of the model;

Table 1-3: List of deliverables relevant for new users.

Reference	Deliverable Title	WP No.	Lead beneficiary number	Dissemination level
D2.1	Project web page	2	13	PU
D5.2	Data description document	5	1	PU
D3.3	Model configurations (implementation and documentation)	3	4	PU
D10.1	Final methodological description of assessment model	10	1	PU
D3.4	Final date structure documentation	3	4	PU
D6.1	A report on scenario generation and software (including documentation for scenario generation)	6	2	PU
D8.2	Final report on the passenger demand model	8	3	PU
D9.2	Final documentation of the assignment models	9	1	PU
D7.2	Final report on the freight and logistics model	7	2	PU
D4.1	A technical documentation of the model structure and operation	4	4	PU
D2.3	Scientific documentation report	2	1	PU
D12.3	User guide	12	4	PU
D11.1	Model validation	11	1	PU

As seen from the tables the deliverables include;

- Dissemination activities
- Data descriptions
- Methodological reports which describe the underlying mathematical models of TT3
- User guides and documentation

External dissemination activities

The external dissemination activities include newsletters as posted on our web-page throughout the model development phase. In total six newsletters have been published describing the various stages of the model development. Refer to http//www.transtools3.eu

As described above, an important part of the impact is the spin-off to research activities which are either directly or indirectly related to the model development. Below we present a sequence of papers which are linked closely to the TT3 model.

Jensen, A.F., de Jong, G., Thorhauge, M., Rich, J., Dekker, T., Johnson, D., Cabral, M.C., Bates, J., Nielsen, O.A. (2017). A model for freight transport chain choice in Europe. *Transportation Research Part E*. Submission to special issue by end March 2017.

Anders Fjendbo Jensen, Mikkel Thorhauge, Gerard de Jong, Jeppe Rich, Thijs Dekker, Daniel Johnson, Manuel Ojeda Cabral, John Bates, Otto Anker Nielsen[7] (2016). A model for freight transport chain choice in Europe. Accepted for hEART Conference, Delft, 2016.

These papers describe in detail the logistic model that has been developed in TT3. As seen, the work has been carried out as collaborative work between many different authors from different entities. The papers are a direct consequence of the TT3 model development.

de Jong, G., Tanner, R., Rich, J., Thorhauge, M., Nielsen, O.A., Bates, J. (2017). Modelling Production-Consumption Flows Of Goods In Europe: The Trade Model Within Transtools3. *Journal of Shipping and Trade*. Submission to special issue by end March 2017.

Gerard de Jong, Reto Tanner, Jeppe Rich, Mikkel Thorhauge, Otto Anker Nielsen, John Bates (2016). Modelling production-consumption flows of goods in Europe: the trade model within Transtools3. Accepted for ETC proceedings, 2016.

These papers describe the trade-model in the TT3 model, which is the other important component of the freight model. These papers are a direct consequence of the TT3 model development.

Rich, J., Nielsen, O. A., 2015, System convergence in transport models: algorithms efficiency and output uncertainty, *European Journal of Transport and Infrastructure Research,Vol.15(3), 317-340.*

This paper is partly related to the TT3 model system as it describes a methodology which has been applied in the TT3 framework to improve model convergence.

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[7] Order of authors not final.

Rich, J., Mabit, S., 2015, Cost damping and functional form in transport models, *Transportation, 43:889:912*.

This paper is partly related to the passenger model and the consideration of functional form as it considers the cost-damping of elasticities and which functional forms to use.

Rich, J. and Hansen, C.O. 2016; The Danish National Passenger Model – Model specification and results. *European Journal of Transport and Infrastructure Research*. 16(4): 573-599.

This paper is partly related to the TT3 model in that some of the technology that has been applied in the Danish national model has been applied in TT3 and vice versa.

Rich, J. 2016; A spline function class suitable for demand models. *Econometrics and Statistics*, Marts 2017. Under review.

This paper is linked to the choice of functional form applied in the logistic model. Some of the functions as developed in this paper have been tested in the freight model and the function has also found its way into the route choice models.

Rasmussen, T.K., Nielsen, O.A., Watling, D.P., Prato, C.G., 2017. The Restricted Stochastic User Equilibrium with Threshold model: Large-scale application and parameter testing. *European Journal of Transportation and Infrastructure Research,* 17(1), 1-24.

Watling, D.P., Rasmussen, T.K., Prato, C.G., Nielsen, O.A., 2015. Stochastic user equilibrium with equilibrated choice sets: Part I – Model formulations under alternative distributions and restrictions. *Transportation Research Part B: Methodological*, 77, 166-181. Elsevier.

Rasmussen, T.K., Watling, D.P., Prato, C.G., Nielsen, O.A., 2015. Stochastic user equilibrium with equilibrated choice sets: Part II – Solving the restricted SUE for the logit family. *Transportation Research Part B: Methodological*, 77, 146-165. Elsevier.

Watling, D.P., Rasmussen, T.K., Prato, C.G., Nielsen, O.A., 2015. Stochastic user equilibrium with equilibrated choice sets. *Proceedings of the 4th Symposium of the European Association for Research in Transportation*, September 9-11,Copenhagen, Denmark.

Rasmussen, T.K., Watling, D.P., Prato, C.G., Nielsen, O.A., 2015. Restricted stochastic user equilibrium with Threshold (RSUET) – Model formulation, solution methods and large-scale test. *Proceedings of the 4th Symposium of the European Association for Research in Transportation*, September 9-11,Copenhagen, Denmark.

These papers are linked to a new path-based methodology which has been implemented in the TT3 road assignment.

Policy impacts

The TT3 model represents a model system, which is primarily aimed at investigating large scale European projects. Moreover, even at the aggregated European level it is primarily aimed at benchmarking of different projects rather than being a reliable forecasting model.

To summarise, the TT3 system is capable of;

- Analysing large European projects on a “one-to-one basis” if these refer to largely similar reference scenario settings.
    - Hence, the model can be used to benchmark performance of infrastructure projects with reference to a given exogenous baseline.
    - It is important that model results are used and interpreted with care; hence, results from urban areas should be treated with care and consumer surplus effects equally so.
- Analysing fundamental relationships between population, GDP and transport activity over time.
    - Although analysis of transport projections over time is difficult for a static comparative model with no dynamics integrated, the model has been tested to reflect historical links between economy and transport. Hence, the model can be used to assess demand projections, although these will be rather uncertain.
- The outputs of the model can be used in a variety of other models to provide more detailed impact analysis of environmental and as a tool to judge how transport activity will develop under given conditions.
- Doing multimodal investigations for both passenger and freight transport policies.
- Analysing overall European road charging policies, e.g. such as a Euro Vignette system or similar.
- Analysing effects of specific infrastructure plans against a do-nothing scenario and in turn evaluating consumer surplus effects approximately.

These capabilities can lead to a number of impacts from a policy perspective. In particular it will help and support the planning of the European infrastructure and provide an impartial political instrument for benchmarking between different projects. These capabilities are supported by a wide range of different model outputs from key figures and maps. The configurations can control which maps are printed and which key figures are produced.

Key figures (aggregated numerical results) are calculated in each model run where applicable, depending on configurations. With configurations, users can decide to have the key figures exported to a file in csv or excel format. Below in Figure 1-6 is shown an example of key figures.

Scenario	OuterIteration	CountryCode	Country	GpkmRoad	GpkmRail	GtkmTruck	GtkmRail	GtkmIWW	GvkmCar	GvkmTruck
TS_2030_Baseline_K	4	AL	Albania	13.6	0.1	2.1	0.1	-	7.0	0.2
TS_2030_Baseline_K	4	AT	Austria	88.6	14.2	49.6	25.2	1.5	60.3	5.3
TS_2030_Baseline_K	4	BA	Bosnia	17.2	0.2	7.6	0.5	0.2	8.7	0.8
TS_2030_Baseline_K	4	BE	Belgium	128.3	14.3	42.6	24.2	16.1	88.6	4.4
TS_2030_Baseline_K	4	BG	Bulgaria	49.6	3.2	42.2	15.1	4.6	28.1	4.4
TS_2030_Baseline_K	4	BY	Belarus	49.6	8.9	111.7	2.7	-	25.4	8.7
TS_2030_Baseline_K	4	CH	Switzerland	131.2	29.7	23.2	12.9	0.0	90.5	2.0
TS_2030_Baseline_K	4	CY	Cyprus	7.6	0.0	-	-	-	4.0	-
TS_2030_Baseline_K	4	CZ	Czech Republic	82.2	13.2	61.4	21.4	0.1	46.6	5.1
TS_2030_Baseline_K	4	DE	Germany	922.4	122.3	499.0	175.3	70.2	630.7	53.9
TS_2030_Baseline_K	4	DK	Denmark	57.2	8.0	13.4	6.0	-	39.8	1.3
TS_2030_Baseline_K	4	EE	Estonia	12.3	0.4	7.9	2.1	-	6.5	0.8
TS_2030_Baseline_K	4	ES	Spain	469.6	50.4	242.4	10.9	-	293.2	22.6
TS_2030_Baseline_K	4	FI	Finland	70.9	5.2	57.5	14.8	-	49.1	5.0
TS_2030_Baseline_K	4	FR	France	848.6	133.3	357.4	86.2	28.6	532.1	35.5
TS_2030_Baseline_K	4	GR	Greece	108.5	1.9	43.6	4.7	-	67.7	4.0
TS_2030_Baseline_K	4	HR	Croatia	34.1	1.7	19.2	3.2	0.0	20.9	1.6
TS_2030_Baseline_K	4	HU	Hungary	68.1	12.0	30.7	18.9	2.2	42.0	3.0
TS_2030_Baseline_K	4	IE	Ireland	56.8	2.5	25.3	0.5	-	40.8	1.9
TS_2030_Baseline_K	4	IS	Iceland	7.0	0.0	-	-	-	4.9	-
TS_2030_Baseline_K	4	IT	Italy	705.3	78.3	227.9	26.9	-	440.0	24.5
TS_2030_Baseline_K	4	LI	Liechtenstein	0.5	0.0	0.1	0.0	-	0.4	0.0
TS_2030_Baseline_K	4	LT	Lithuania	35.9	0.7	24.6	18.4	0.0	18.5	2.6
TS_2030_Baseline_K	4	LU	Luxembourg	8.5	0.5	1.3	2.1	-	6.4	0.1
TS_2030_Baseline_K	4	LV	Latvia	17.9	1.1	24.3	8.8	0.0	9.1	2.5
TS_2030_Baseline_K	4	MD	Moldavia	11.2	0.6	49.5	1.7	-	5.9	3.9
TS_2030_Baseline_K	4	ME	Montenegro	9.1	0.1	1.2	-	-	4.7	0.1
TS_2030_Baseline_K	4	MK	Macedonia	7.5	0.2	2.9	0.4	-	4.7	0.2
TS_2030_Baseline_K	4	MT	Malta	2.4	0.0	-	-	-	1.2	-
TS_2030_Baseline_K	4	NL	Netherlands	167.8	19.9	63.2	13.5	50.9	126.0	6.5
TS_2030_Baseline_K	4	NO	Norway	104.5	4.6	61.5	13.5	-	71.2	3.4
TS_2030_Baseline_K	4	PL	Poland	384.7	38.1	190.0	78.9	2.0	214.5	19.4
TS_2030_Baseline_K	4	PT	Portugal	97.3	7.5	21.5	1.3	-	67.5	2.3
TS_2030_Baseline_K	4	RO	Romania	106.3	12.7	71.6	31.5	4.0	54.0	7.7
TS_2030_Baseline_K	4	RU	Russia	1'021.5	96.8	1'224.9	35.4	-	526.5	95.3
TS_2030_Baseline_K	4	SE	Sweden	120.2	14.9	51.9	40.3	-	83.4	4.2
TS_2030_Baseline_K	4	SI	Slovenia	27.8	1.1	6.1	4.0	-	15.3	0.6
TS_2030_Baseline_K	4	SK	Slovak Republic	40.8	4.2	25.6	9.2	0.2	23.1	2.1
TS_2030_Baseline_K	4	TR	Turkey	240.7	10.8	246.9	30.7	-	151.7	25.0
TS_2030_Baseline_K	4	UA	Ukraine	258.2	38.9	248.9	46.9	-	133.4	22.4
TS_2030_Baseline_K	4	UK	United Kingdom	782.7	70.8	211.5	26.7	0.2	544.8	22.0
TS_2030_Baseline_K	4	YU	Serbia	66.3	1.0	21.3	6.2	2.5	34.0	2.0

Figure 1-6: TT3 key figures.

Maps are produced using flows from the assignment models. The flows are produced each time the assignment models are run. Production of maps from the flows requires considerable calculation time, so it is up to the users to choose a configuration where maps are produced only if necessary. Below in Figure 1-7 is shown an example of an auto-generated map. Maps can also show filters for traffic using certain bottlenecks or between sets of zones.

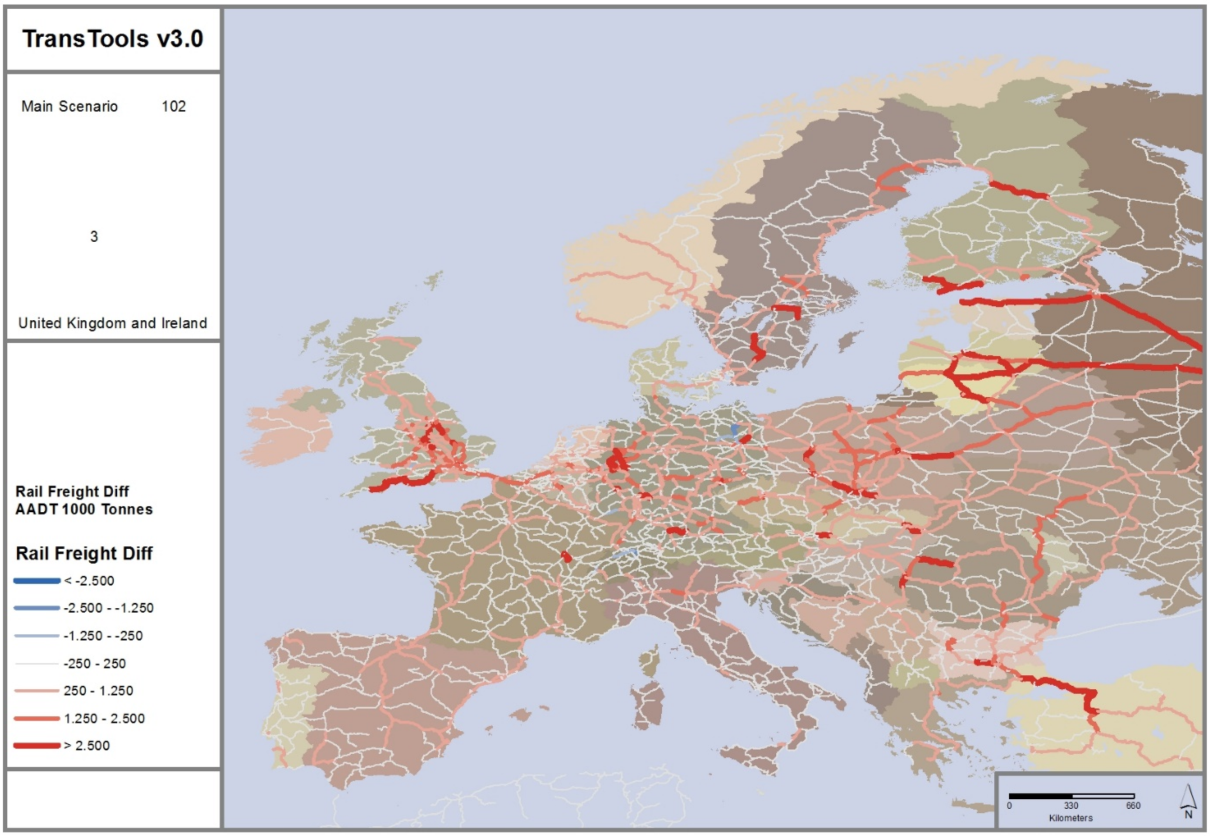

Figure 1-7: TT3 auto-generated map

1.6 Address of the project public website

http://www.transtools3.eu/

List of abbreviations and acronyms

AADT	Annual Average Daily Traffic
ADA	Aggregate-disaggregate-aggregate
ArcGIS	A system for designing and managing solutions through the application of geographic knowledge (ESRI)
ATE	AustriaTech – TT3 consortium partner
CD/DVD	Compact Disc/Digital Versatile Disc
CO	EU FP7 terminology for dissemination level: Confidential, only for members of the consortium (including the Commission Services)
CO2	Carbon dioxide
D	Deliverable (Used in the Grant Agreement of EU FP7 projects)
DATELINE	An EU funded project with the objective – among others – to develop a survey design for long-distance passenger travel to be applied in all Member States addressing the needs of the respondent and implement the state-of-the-art in travel behaviour surveys. DATELINE refers to: 'Design and Application of a Travel Survey for European Long-distance Trips based on an International Network of Expertise'.
DC	Distribution Centres
DG Tren	European Commission's Directorate General for Transport and Energy
DG Move	European Commission's Directorate General for Mobility and Transport
DTU	Technical University of Denmark – TT3 consortium coordinator
ECHO	ECHO refers to a survey conducted in France (2004) on logistic chains based on the door-to-door tracking of each shipment, from the shipper to the final consignee.
EFTA	European Free Trade Association
E.g.	For example
Et. al.	Et. al. is an abbreviation for *et alia / et alii / et aliae.* The phrase means: "and others".
Etc.	Etc. is an abbreviation for *Et cetera*. The phrase means: *"and other similar things"* or *"and so forth"*
ETH	Die Eidgenössische Technische Hochschule, Zürich – TT3 consortium partner
ETISplus	ETISplus is a research project under the EU FP7 programme. ETIS stands for: European Transport Policy Information System. The ETISplus project builds upon the strengths of the previous ETIS database project (2005) and addresses the lessons learnt. The primary goal of ETIS is to provide policy makers and policy analysts with the capability to include the European dimension in monitoring developments relevant for transport and transport policy. http://www.etisplus.eu/default.aspx
EU	European Union
EU27	Refers to the European Union in the period 2007–2013 when it had 27 countries, or the countries that were members then.
EUR	Euro

EUROSTAT	Eurostat is the statistical office of the European Union situated in Luxembourg. Its task is to provide the EU with statistics at European level that enable comparisons between countries and regions.
Excl.	Excluding
F2F	Firm-to-firm
FP	Framework Programme
FREIGHTVISION	Is a project aiming at developing visions and action plans for transport and technology policy in the EU
FT	Fomterv Mernoki Tervezo Zrt. – TT3 consortium partner
FTTE	Univerzitet u Beogradu - Saobracajni fakultet – TT3 consortium partner
GDP	Gross Domestic Product
GIS	Geographical Information System
IA	Impact assessment
I.e.	That is
Incl.	Including
IPR	Intellectual Property Rights
ITS/Leeds	Institute for Transport Studies, University of Leeds
IWW	Inland Water Ways
KM	Kilometre
KTH	Kungliga Tekniska Hoegskolan – TT3 consortium partner
LoS	Level of Service
MSA	Method of Successive Averages
NACE	Refers to Nomenclature statistique des activités économiques dans la Communauté européenne (English: the Statistical Classification of Economic Activities in the European Community). NACE is a European industry standard classification system consisting of a 6 digit code.
NEST	NESTEAR SARL: Nouveaux ESpaces de Transport en Europe Applications de Recherche– TT3 consortium partner
NGO	Non-Governmental Organization
NST/R	Standard Goods Nomenclature for Transport Statistics
NTUA	National Technical University of Athens – TT3 consortium partner
NUTS	Nomenclature of territorial units for statistics. The NUTS classification is a hierarchical system for dividing up the economic territory of the EU.
OD	Origin-Destination
PC	Production-Consumption
PRIMES	The PRIMES model is an EU energy system model which simulates energy consumption and the energy supply system.

PU	EU FP7 terminology for dissemination level: Public
RAMON	Reference and Management of Nomenclatures
RE	EU FP7 terminology for dissemination level: Restricted to a group specified by the consortium (including the Commission Services)
RoRo	Roll-on/Roll-off (Roll-on/roll-off ships are vessels that are used to carry wheeled cargo)
RSUET	Restricted stochastic user equilibrium with Threshold (RSUET) – Model
TA	Traffic Analyst - Traffic Analyst is a software package for transport modelling. It is e.g. being used as the basis for the assignment models in the TransTools3 project.
TEN	Trans-European Transport Network
TEN Connect	TEN Connect is a project financed by the European Commission finalised in December 2009. TEN Connect analysed the existing Trans European Network for Transport (TEN-T) as part of the process of developing the EU transport policy from 2010 and onwards.
TP	TetraPlan – TT3 consortium partner
TrafficAnalyst	TrafficAnalyst is a software package for transport modelling. It is e.g. being used as the basis for the assignment models in the TransTools3 project.
TransTools	Tools for Transport Forecasting and scenario testing
TT	TransTools
TT1, TT2, TT2.5, TT3	TransTools version 1, 2, 2.5 and 3
UB	Univerzitet u Beogradu - Saobracajni fakultet – TT3 consortium partner
UNIVLEEDS	University of Leeds – TT3 consortium partner
UOXF JQ	The Chancellor, Masters and Scholars of the University of Oxford – TT3 consortium partner
VoT	Value of Time
WP	Work Package