1 The Øresund Traffic Model - An introduction

1.1 Background and Objective

The Øresund Traffic Model has been designed for forecasting the future amount of traffic on the tolled Fixed Link between Copenhagen, Denmark and Malmø, Sweden and on around 25 competing ferry routes between Denmark, Sweden, Norway, Germany and Poland.

The Fixed Link has a total length of about 17 km and connects two major cities in Northern Europe. The Link will open in year 2000 for both road and rail traffic; access connection in form of new motorway sections and new rail lines have also been constructed.

The model is developed for Øresundskonsortiet, a specific purpose company owned equally by the Danish and Swedish governments, by COMVIN J/V. [1]

The aim of the model has been to establish a comprehensive planning tool, which will facilitate forecasting of future traffic levels with a wide range of planning and policy assumptions such as: different fare policies on the Fixed Link and competing ferry routes, the transport service offered for both public and private transport users, macro-economic development, changed restrictions on land use, different transport policy options e.g. fuel taxes.

The model considers all relevant modes of travel including private vehicles, buses, trains, air passengers, various truck types and freight trains.

2 Scope of Model

The Model is based on an extensive set of RP and SP survey collected by COMVIN. Statistical analysis of the survey data gives rise to Model Parameters which determine much of the behavioural modelling in the Traffic Model. Survey data describing the observed pattern of trips in the study area forms an input to the forecasting process and is thus also part of the model. Inventory data is used to provide a description of the highway and public transport networks, and the services running on the public transport network.

The modelling processes are designed to provide the best forecasts for the different routes for traffic crossing the Øresund. In making the forecasts, the model estimates information at a much finer level of detail, including between which origin and destination zones trips travel, which network links, and which public transport services they use. However, the model is designed for using this information in aggregate (for each Øresund crossing link), and care should be taken when interpreting individual elements of more disaggregate information, such as the numbers of trips on a particular public transport service.

[1] COWI Consulting Engineers and Planners, Denmark & MVA Consultancy, UK & InRegia, Sweden.

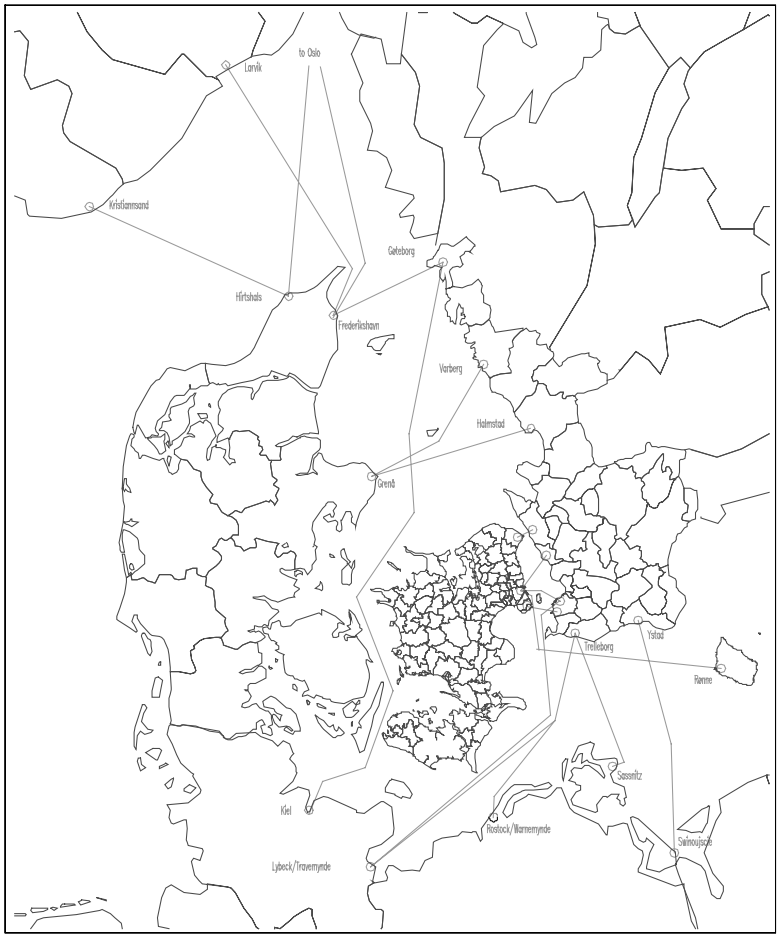

Figure 1 Indication of Øresund Crossings and Zoning System (167 zones)

The Model contains distinct modelling for long and short distance trips. Modelling of short distance trips is based on more extensive information and is therefore more precise than the corresponding modelling of long distance trips. Figure 2 shows the area and zoning associated with the short distance modelling, centred on the region of the Fixed Link.

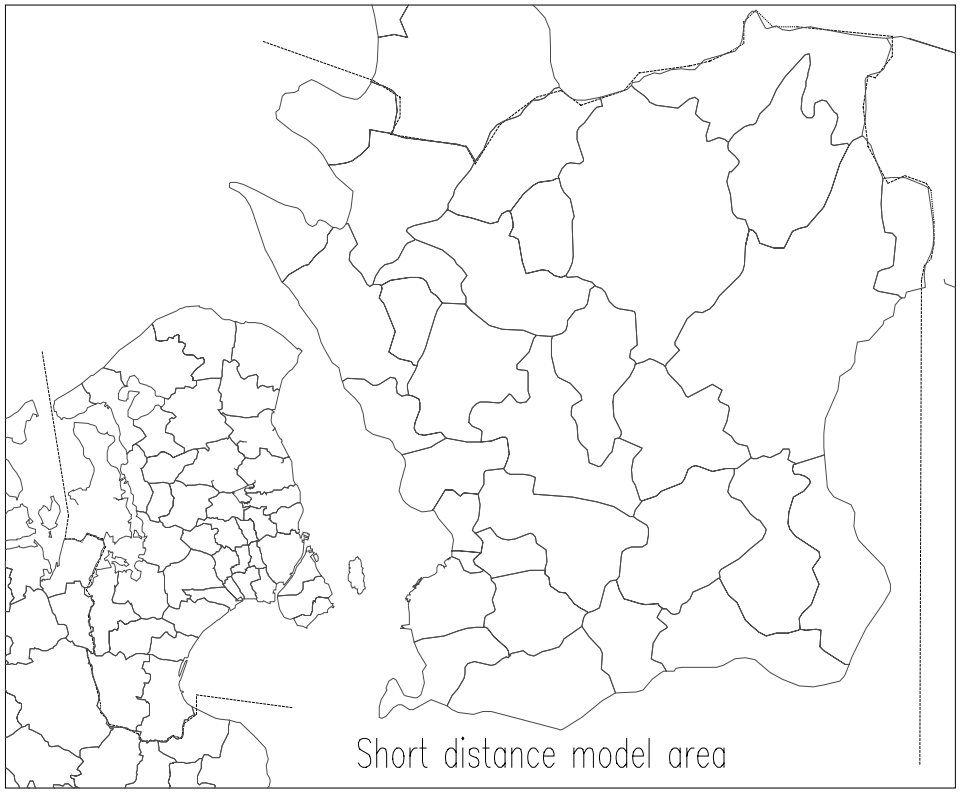

Figure 2 Area and Zones of Short Distance Model

There are different sub-models relating to the long- and short-term situations. In the long term, the influence of the major change in the transport network, which the Øresund fixed link represents, is allowed to alter land use, which in turn may alter the nature and demand for travel. It is left to the user's discretion whether to apply the short- or long-term sub-models in any particular application, that is, whether to consider the potential effects of changes in land use.

There are over 27 different crossing routes which are relevant to the different components of the Traffic Model, namely, short- and long-distance passenger trips, and freight. Most of the crossings are associated with the Long Distance model, and there are only 5 crossings in the Short Distance modelling.

3 Passenger Models

The Øresund Traffic Model contains a set of sub-models for the different elements of the forecasting, which are outlined in this section. Short distance trips are defined as trips whose origin and destination zones are both in the Øresund region, defined as the Hovedstad region and Skåne.

3.1 Short Distance Passenger Model

The following trip types are defined:

Trips made by residents in the Øresund region:
- Work trips
- Shopping trips

- Business trips
- Other trips excluding sailing trips and airport access/egress trips.

Short distance trips made by people not resident in the Øresund region:
- Business trips
- Other trips

Special-purpose trips:
- Airport access/egress trips across the Øresund (using SAS services)
- Sailing trips (trips which use Øresund ports, but which do not cross the Øresund itself).

The model for the generation of the growth of total short distance passenger trips in the Øresund region is divided into four parts, one for each trip type: work trips, business trips, shopping trips, and other trips.

For Work, Shopping, Business, and Other trip types (all considered home based, such that the origin zone is the home zone), the traffic models include destination choice, mode choice and choice of crossing. For trips made by people not living in the region, the traffic model includes only mode choice and choice of crossing. The destination choice is an incremental model.

The following trip sectors are considered:

A Swedish resident travelling within Skåne	B Swedish resident travelling to or from the Hovedstad region
C Danish resident travelling to or from Skåne	D Danish resident travelling within the Hovedstad region

Table 1 Definition of Short Distance Passenger Trip Sectors A,B,C,D.

Choice of mode and crossing considers combinations of origins and destinations in sectors B and C, for each sector separately using absolute hierarchic logit modelling.

The modes are:

1. car all the way,
2. bus all the way,
3. train all the way ,
4. car on the residence side, disembarkment, car on the opposite side, (only for work trips)
5. car on the residence side, disembarkment, public transport on the opposite side,
6. public transport on the residence side, disembarkment, car on the opposite side,
7. public transport on the residence side, disembarkment, public transport on the opposite side.

The different crossings are:

- for car and bus all the way — Helsingør-Helsingborg
Limhamn-Dragør
Fixed Link

- for train all the way — Fixed Link

- for disembarkment — Helsingør-Helsingborg
  Landskrona-København
  Malmö- København
  Limhamn-Dragør.

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The number of short distance trips which are generated and attracted to each zone are dependent in the modelling on population, employment and economic activity data.

For forecasting in the long term, the facilities of the IMREL model are appropriate to forecast population and employment levels by zone. IMREL provides a model of land-use transport interaction.

3.2 Long Distance Passenger Model

The long-distance model is an incremental hierarchical mode and route choice model based on the logit choice formulation of trips across the Øresund.

Long distance trips are defined as the trips which **do not** have both origin and destination in the Øresund region which in turn is defined as the Hovedstad region and Skåne.

Like the short-distance model, the movements are organised in a production-attraction (P/A) fashion and the home-based trips are the most important in the modelling. However, unlike the short-distance model, no distinction is made about respondents' residence or nationality.

The model is to generate the rate of change in long distance passenger trips between zones. This is done with a model describing tourist departures and arrivals by countries. First a calibrated matrix for the base year (1995) showing flows between countries is calculated. Then a corresponding matrix for a forecast year (e.g. 2010) is produced. The ratio between the two matrices gives the rates of change in flows between countries. These results are disaggregated into zones.

Two trip segments are used relating to journey purpose:
- employer business trips;
- other trips (including leisure, shopping, commuting, etc)

For both trip purposes (business, other) the modes for crossing the Øresund are:
- car all the way ;
- bus all the way;
- train all the way;

and four types of disembarkation modes;
- car on one side, ferry, car on the opposite side;
- car on one side, ferry public transport on the opposite side;

- public transport on one side, ferry, car on the opposite side;
- public transport on one side, ferry, public transport on the opposite side.

There are a total of 50 different mode crossing combinations for the long-distance model (excluding Fixed Link but including all four types of disembarkation):

- for car all the way
  Hirtshals-Kristianssand
  Hirtshals-Oslo
  Frederikshavn-Oslo
  Frederikshavn-Larvik
  Frederikshavn-Göteborg (Stena Line)
  Frederikshavn-Götenborg (SeaCat)
  Grenå-Varberg
  Grenå-Halmstad
  Helsingør-Helsingborg (Scandlines)
  Dragør-Limhamn
  København-Rønne
  Trelleborg-Travemünde
  Trelleborg-Rostock (TR-Lines)
  Trelleborg-Rostock (HansaFerry)
  Trelleborg-Sassnitz
  Malmö-Swinoujscie
  Ystad-Swinoujscie
- for train all the way
  Helsingør-Helsingborg
- For bus all the way
  Helsingør-Helsingborg (Scandlines)
  Dragør-Limhamn
- for disembarkation
  Helsingør-Helsingborg (Scandlines)
  Helsingør-Helsingborg (Sundbus)
  Havnegade- Malmö (Flyvebadene)
  Havnegade- Malmö (Shoppinglinien)
  Havnegade- Malmö (Pilen)
  Dragør-Limhamn
  Havnegade-Landskrona (Direkten)
  København-Rønne

The fixed link appears as a new crossing under the car and bus modes. According to future plans, it will also replace the current rail crossing across the Øresund.

4 Freight Model

The model is applied separately for two different commodity groups, bulk and general cargo. In addition, there is a separate model for empty trucks.

Freight modes which are modelled are (for the ports of the ferry routes which carry freight unit):

- Solo
- Articulated vehicle
- Road train
- Trailer
- Train and Combi.

The freight growth model distinguishes between long and short distance transports. Both models are gravity based models but with different parameters and explanatory variables.

The freight route/mode choice model forecast the volume of freight in tonnes and the number of vehicles on each of the crossing links. The model is implemented as an hierarchic logit model in absolute form.

The freight crossing route distribution models interacts with the freight growth model. Changes in supply induce increased traffic through the growth model and mode shifts in the models for loaded route choice. These changes are reflected in the model for empty route choice.

5 The PC version of the model

The forecasting system has a number of different elements which are linked together to provide both a forecasting and information system. The system's elements are split between a central, 'server', computer and local, 'client', computers, which are connected via a computer network. Users operate the client computers under Windows. The main software elements of the system are:

- a central, SQL Server database;
- Microsoft Access database software, which provides the interface to the SQL Server database, as well as permitting local database operations;
- a TRIPSWIN interface to the Traffic Model, which uses TRIPS and IMREL software. This also offers connections to the databases;
- Excel spreadsheet software.

The relationships between these elements and the flow of data are shown in Figure 3.

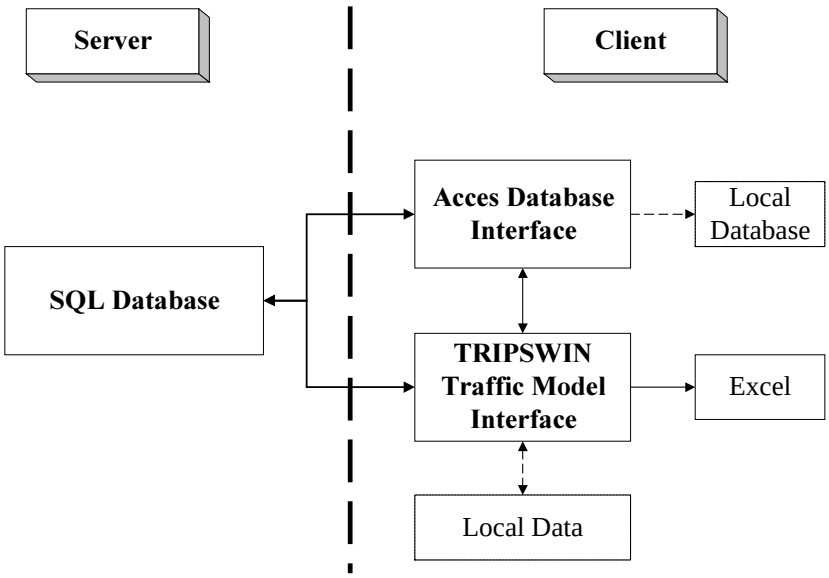

Figure 3 Main System Elements and Dataflow

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An integral part of the Øresund Traffic Model is provided by its associated Database. Initially, this Database includes:

- the supplied set of Primary Data, which reflects the surveyed data upon which the model is based;

- a representation of the Base-Year situation in 2000 with the Fixed Link opened. This information is in the form of a Project which may be used as the starting point for making forecasts;

The Database may be used as an information source in its own right, as well as providing the data required for running the Traffic Model.

The interface to the Database is provided by Microsoft Access, which provides access to the central Microsoft SQL Server database where the information is actually held. The SQL Server database allows connections to other systems, this enables such software as the SAS statistical analysis package to access Traffic Model information. Besides providing an interface to the SQL Server database, Microsoft Access can be used as a database system on its own. This provides a facility whereby users can create their own local, Access, databases using information derived from the Traffic Model.

The Øresund Traffic Model provides several ways in which information may be reported:

- via Access database interface
- via MVGRAF network graphics (and MicroStation/AutoCAD)
- via Excel spreadsheet