FREIGHT TRANSPORT STATISTICS

- Statistical sources and requirements for freight transport modelling

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PREFACE

This paper was written as part of a research study funded by the Danish Transport Council.

The specific aim of the paper is to contribute to the improvement of the statistical basis for strategic freight transport modelling, with a view to policy decision support. The scope has been limited. Further steps to elaborate on this topic would require pilot study surveys and the analysis of detailed data extracts from available statistical sources.

Valuable ideas and comments were provided by Morten Steen Petersen, TetraPlan A/S, and co-ordinator of the research study, and by Erik E. Grib, Statistics Denmark. However, any mistakes and shortcomings reflected in the paper are solely the responsibility of the undersigned.

The potential target groups of this paper are the Statistics Denmark, the Danish Ministry of Transport, and local government administrations. Another target group is the "Dansk Transport Forskning" (DTF) that was established 1 August 2000. Among the declared priorities of this new research institution are the development of improved databases for freight transport and the development of freight transport modelling.

Recently, the Danish Transport Council has launched several interrelated studies within the fields of transport statistics and modelling. There would be a need for the Transport Council to arrange a few workshops or seminars, in order to stimulate dissemination, to provide synergy of the already launched research activities, and to avoid duplication of work.

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Remark:
Since 2000, several changes have happened in terms of related legislation, institutions, research etc. The Danish Transport Council terminated its activities in 2002, following a government decision; the previous 13 counties in Denmark were replaced in 2007 by five regional administrations; DTF was merged into DTU Transport in 2008; and the establishment of a Danish national transport model was initiated in 2009 and is still on-going in 2013. New traffic data collection methods are also promising, based on information technology tools such as smart-phones and Bluetooth etc. However, most of the general issues about statistics pointed out in this report are still valid.

Jørgen Kristiansen, Aalborg 2013

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ABBREVIATIONS AND GLOSSARY

ABBREVIATIONS

AKF	Abbreviation for the research institute of the Danish counties and municipalities
ATIS	**A**lpine **T**ransport **I**nformation **S**ystem (pilot in the MESUDEMO project)
CN	**C**ombined **N**omenclature
CPA	**C**lassification of **P**roducts by **A**ctivity
CTSE	**C**ommodity Classification for **T**ransport **S**tatistics in **E**urope
EC	**E**uropean **C**ommission
ECTM	**E**uropean **C**onference of **T**ransport **M**inisters (Ministers of Transport)
EDI	**E**lectronic **D**ata **I**nterchange
ETIS	**E**uropean **T**ransport Policy **I**nformation **S**ystem
Eurostat	**Stat**istical Office of the **Euro**pean Communities
EU	**E**uropean **U**nion
GDP	**G**ross **D**omestic **P**roduct
GIS	**G**eographical **I**nformation **S**ystems
ICT	**I**nformation and **C**ommunication **T**echnology
NST	**N**omenclature Uniforme des Marchandises pour les **S**tatistiques de **T**ransport
NST/R	**N**omenclature Uniforme des Marchandises pour les **S**tatistiques de **T**ransport **R**evisée
NUTS	**N**omenclature des **U**nités **T**erritoriales **S**tatistiques
OD	**O**rigin-**D**estination
SAD	**S**ingle **A**dministrative **D**ocument (Customs declaration document)
SCM	**S**upply **C**hain **M**anagement
SIKA	**St**atens **I**nstitut för **K**ommunikations**A**nalys (the Swedish Institute for Transport and Communication Analysis)
SITC	**S**tandard **I**nternational **T**rade **C**lassification (used by the UN)
TEN-T	**T**rans-**E**uropean **N**etworks for **T**ransport
TEU	**T**wenty Foot **E**quivalent **U**nit (used for containers)
TRAINS	Database for the Eurostat **Tra**nsport Statistical **In**formation **S**ystem (covers the road, rail and inland waterways modes)
UN-ECE	**U**nited **N**ations Organisation’s **E**conomic **C**ommission for **E**urope

GLOSSARY

Consignment:
Every unique delivery of one type of goods to/from one unique receiver/deliverer (SIKA, 1999).

Entrepôt:
Temporary warehousing of goods in transit (storage and export).

EXTRASTAT:
Reporting method for trade with non-EU countries (extra-EU trade statistics)

Intermodality:
The Commission writes the following definition in COM(97) 243 final: "Intermodality is a characteristic of a transport system, that allows at least two different modes to be used in an integrated manner in a door-to-door transport chain".

INTRASTAT:
Reporting method for trade with other EU countries (intra-EU trade statistics)

Macro-economy:
Dealing with aggregated economies of a county, city, region, country, and other administrative or geographically defined unit.

Micro-economy:
Dealing with the economy of an organisation, a company or a specific project.

Macro (aggregate) models:
Dealing with aggregated transport flows.

Micro (disaggregate) models:
Dealing with specific consignments, companies or locations.

Tare:
Weight of the container in which the goods are packed, or of the vehicle carrying them. Thus tare is included when the goods are weighed together with the carrying container or vehicle.

Transport units:
In the ECMT terminology, "transport unit" comprises both transport equipment and the means of transport or rolling stock (vehicle/lorry, vessel/ship, train etc.). In the present paper, the term "transport unit" is mainly used to indicate the rolling stock. In the cases where transport equipment such as containers, swap bodies, semi-trailers etc. are addressed, the terms "loading unit" or "unit loads" are being used.

0. INTRODUCTION

0.1 Aim, scope and limitations of the paper

Focus of the present paper is on the needs for freight transport statistics in order to facilitate the elaboration of freight transport modelling structures and potential model applications at the macro level.

The specific emphasis of the paper is on foreign trade data and freight flow data (transport demand data), and how these data can be combined in order to provide data inputs to freight transport modelling. The statistical sources include trade data, data on goods transport flows between zones, and goods traffic data catch in terminals (including ports) and along routes.

The freight transit flows through Denmark constitute a particular statistical problem as they are included in the observed traffic but not covered by the foreign trade statistics.

Due to the specific aim of this paper, the following topics fall outside its limits and scope, although they are of relevance to transport modelling and strategic transport policy formulation as well:

- Socio-economic data of the zones in question. These data are crucial for establishing cause-effect relations between societal variables and transport systems.
- Transport supply data, such as data about transport networks/infrastructure and services, unless they are considered of relevance to the basic definitions and concepts.
- Micro level models, data and survey methods.
- Structural development of the transport sector industry.

0.2 Contents of the paper

The overall approach of the paper has been to make a comparative review of Danish statistics and relevant EU research findings, in order to assess the applicability and potentials for statistical improvements with a view to freight transport modelling.

Chapter 1 presents some general considerations about the relations between transport modelling and transport data needs. It comments briefly on data categories and relevant EU research activities.

Chapter 2 addresses the zoning requirements of modelling, the NUTS zoning system used by the Eurostat, and the commodity classifications applied by EU in trade and transport statistics.

Chapter 3 presents the main findings of the EU funded INFOSTAT and MESUDEMO research projects in relation to goods transport demand indicators. These findings are of relevance to national statistics and transport modelling as well. The chapter finally provides some short definitions of the new statistical concepts that have been suggested by the two projects.

Chapter 4 presents an overview of relevant Danish statistical sources. The chapter also discusses the issue of transit freight flow data.

Chapter 5 summarises the findings of EU research projects, and suggests some modifications of the present mode-specific statistical reporting for Denmark.

1. TRANSPORT SYSTEMS DATA AND MODELLING

This chapter discusses the data requirements for goods transport modelling, and how these data could be grouped and categorised. Potential application areas in relation to the use of modelling are pointed out, and a short overview is presented of related EU research activities.

As concerns modelling, the focus is on macro-level models. The use of micro-level models is only mentioned briefly. This topic, and related operational information and surveys, are not within the scope of the present paper.

1.1 Main types of data about transport systems

The EU research projects "INFOSTAT" and "MESUDEMO" (see Chapter 3) suggest a distinction between the following categories of data:

A. Spatial and land-use characteristics of the area of analysis
B. Population, economy and other socio-economic characteristics
C. Transport demand indicators (passengers and goods)
D. Transport network characteristics (nodes and links)
E. Transport services indicators (passengers and goods)
F. Transport impact indicators, including public health, traffic safety, environmental impact, land-use and socio-economic impacts.

In relation to transport modelling, these categories of data can be grouped into:

1) Data on external factors influencing transport demand and mobility, i.e. the categories A and B above
2) Data about the transport system, i.e. the categories C, D and E above, and
3) Data on the impact of transport, i.e. category F.

These categories and groupings are illustrated in Figure 1.1.

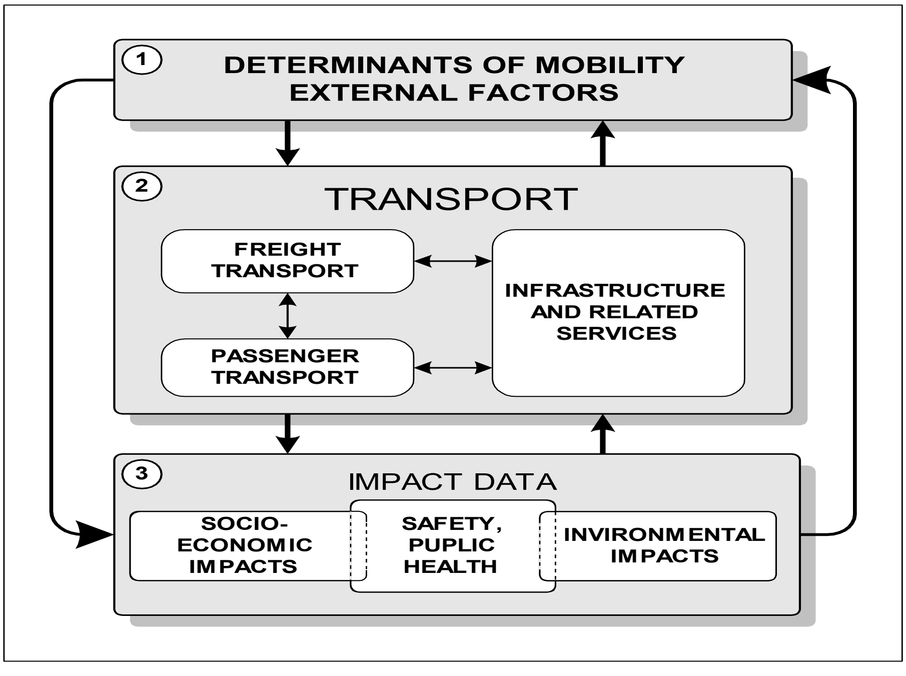

Fig. 1.1: Main structure of transport related data

The figure also indicates that transport systems data could be divided into the so-called *transport demand data* i.e. data about freight transport flows and passenger transport flows, and the so-called *transport supply data*. The latter include data about physical infrastructure and related services, and data about commercial transport services.

A major distinction should be made between 1) bulk of predominantly low-value and 2) other types of cargo such as general cargo and cargo organised in “loading units” or as “unit loads”. Bulk is often served by separate transport systems. This is particularly the case for railway and maritime transport where bulk and unit loads respectively are served by different types of rolling stock and vessels, and by special and separate terminals. No functional or physical inter-linkages exist between the two systems, and as a consequence, it would not make any sense to pool together in a common model the two systems and the two types of goods.

Transport data and policy decisions
The following overview table is a national adaptation of a table presented by the MESUDEMO project (MESUDEMO, 2000). The table presents the topics that are considered relevant for transport policy decisions in relation to the sequence of causes of transport → performance of the transport system → impacts of transport:

Type of data	Requirements for the development of a transport policy database			Identified policy issue
	Causes	**Performance**	**Impacts**	
Macro-economic issues	Explanatory factors of demand	Origin/destination flows	Employment; Value added; Externalities; Spatial impact	Sustainability; Quality of transport
Market issues	Industrial and commercial structure; Organisation of logistics; Value of transport	Vehicle use	Impacts on companies, consumers etc.	Intermodality; Market integration
Transport network issues	Infrastructure investment; Time and costs	Traffic on the network	Costs; Environmental externalities (emissions, accidents, noise etc.)	Environmental requirements; Transport quality; Infrastructure policy; Traffic safety; Interoperability

Fig. 1.2: Relations between data types and policy issues

The quantification of transport flow data is placed under the heading of “performance” and thereby links causes and impact. The MESUDEMO project points out that the challenge is to find a reasonable balance between the needs for detailed data and the cost constrains on producing and maintaining the statistics.

Transport flow data
Transport flow data comprises both overall flow and volume data (macro-level data) and data on observations of individual load consignments (micro-level data).

The available statistical sources about transport flow data are based on traffic counts, aggregated sample surveys, reporting from ports and transport operators, and trade statistics. A number of possible uncertainties are related to these data. As an example, a peculiarity of the present transport statistics is that the weight of containers is included in the tonne-figures of surface transport but not included in sea transport.

The EU studies carried out about the issue (e.g. INFOSTAT and MESUDEMO) unanimously conclude that the lack of more detailed origin/destination (O/D) information is one of the major shortcomings of available transport statistics.

Chapter 4 will focus in more detail on Danish data sources related to freight transport flows. Chapter 4 presents an overview of the statistical publications and sources that are of potential relevance for the description of goods transport patterns and flows with origin and/or destination within the Danish territory, and for transit flows through Denmark. The preliminary selection of data sources in this chapter is made also with a view to the use of statistical variables for the modelling of flows in major corridors or along main routes.

Infrastructure data
Data about the physical transport infrastructure belong to the transport supply information, and comprise a description of the different types of infrastructure and their use. In transport models this description is simplified in order to focus on the aspects that are of significant importance for the particular model. Therefore, in most cases the description and data will not include all elements of the infrastructure. Besides, a number of elements represent average figures (e.g. costs) that cannot be observed in the real world.

Distances in a road and rail network can be defined rather precisely. However, travel speeds will vary according to the different drivers and their way of driving, traffic loads, speed limits and adherence to these, as well as to the organisation of transport units. This implies that the observed individual travel times could deviate considerably as compared to the travel time calculated by the model.

1.2 Strategic models

Freight transport macro models are also termed “strategic models”. They are of potential use within several areas of transport policy decision-making at the national level.

The models should be able to depict how national transport policy measures and public investment initiatives will affect the development of transport demand, mobility, and traffic pattern and travel behaviour. This is illustrated by figure 1.3.

The applications of strategic transport models also fit into a wider scope, including the longer-term impact of policy measures and infrastructure investments on the spatial pattern of economic activities and on regional development.

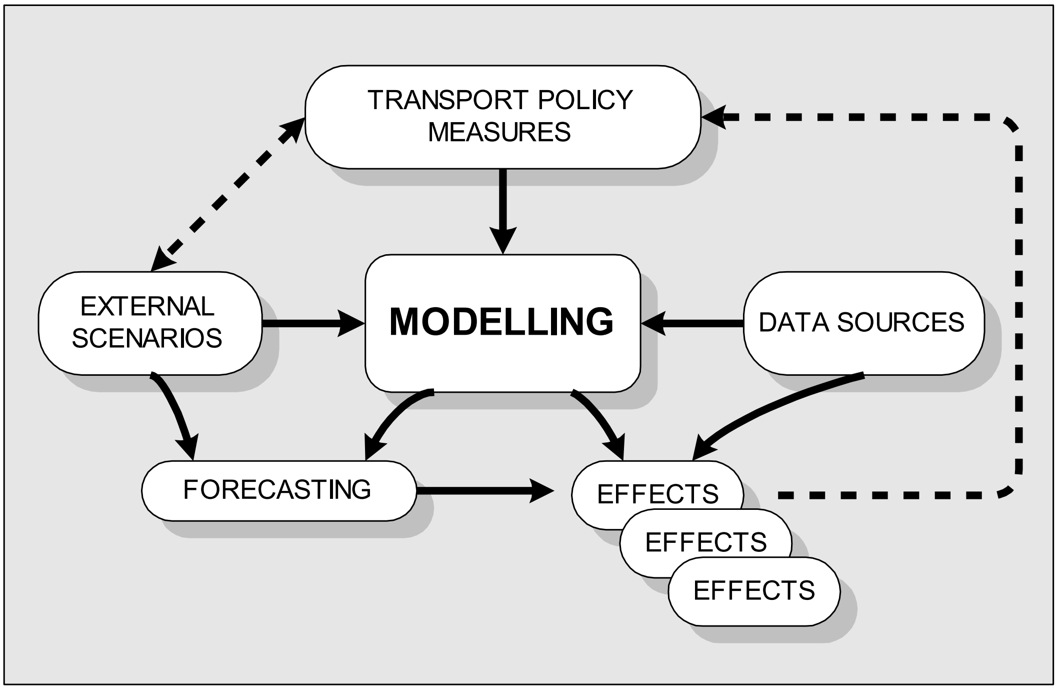

Fig. 1.3: Relations between modelling, statistics, external developments and national/regional transport policy

It should be mentioned that the development of the following freight transport models have required comprehensive data collection:
- The STREAMS model, developed by the ME&P company (UK) in the EU research project "SCENES" about European transport scenarios.
- The STEMM model, developed by the MDS company (UK) in the EU research project "Strategic European Multimodal Modelling" ("STEMM").
- The NEAC model, developed by the Dutch company NEA. This model has been used as traffic forecasting tool on the "TEN Pan-European Corridors" of Helsinki and in the "2020 European" transport projects.

Model application areas
The INFOSTAT and MESUDEMO research projects recommend that a future European transport policy information system ("ETIS") should:
- provide a better understanding of the causes and impact of transport, and improve the ability of monitoring the development of various aspects of transport and mobility;
- provide inputs for the formulation of policy scenarios;
- facilitate the development and application of adequate assessment methodologies in relation to policy measures and alternative strategies.

It appears relevant to apply the ETIS principles at the Danish national level as well, and there is a need for transport modelling as an intermediary tool in all of the three aims mentioned above. A preliminary grouping of the areas of strategic transport model application could be as follows:

- Effects of national transport policy measures on traffic pattern and modal distribution.
- Effects of specific transport infrastructure investment projects on traffic pattern and modal distribution, and the socio-economic and environmental impact of the project.
- Assessment of transport network development plans.
- Transport route and corridor analyses.

Presentation and forecasting of general freight transport flows is an area where various standard software tools are already widely used in other countries and internationally, in order to present the corresponding freight transport flow patterns. This includes the simulation, at the various geographical levels, of different development scenarios. The variables of the scenarios could reflect trade patterns, transport infrastructure supply, costs and service quality levels, and transport policy and regulatory framework etc.

Presentation, analysis and pre-assessment ("ex-ante" evaluation) of the impact of large-scale infrastructure projects have been attempted for the fixed link across the Oresund and a future fixed link across the Fehmarn Belt. Major extensions or standard improvements of the motorway network, the rail network, and changed functions and services of the ports and ferry routes, could be possible future applications as well.

A Norwegian network model

An example belonging to these application areas is the network model for freight transport to and from Norway. This model was developed by the Institute of Transport Economics ("Model for transports in Norwegian foreign trade", 2000). The model is based on an existing Norwegian model for freight transport (NEMO) and the STEMM model for international freight transport.

The data used are foreign trade data from "Statistics Norway" combined with other relevant data, in order to construct the OD-matrices for freight flows.

The Norwegian network model is restricted to the analysis of general cargo. The network of the model is constituted by road links, railway links, sea links, terminals etc. It includes a set of general cost functions that enables it to find solutions that minimise the total costs of a system, given a fixed demand for transport between the zones of the model. In principle the model could analyse the impacts of changes in transport infrastructure and supply, changes in transport demand as well as in transport costs and taxes.

The model was applied to estimate the changes in modal distribution, costs and emissions for six "scenarios". The variables used to define the scenarios were the frequency of liner services in Norwegian ports, the degree of concentration of services in a few important ports, capacity restrictions on the continental road network, conveying times and precision in freight transport, and relative increase of costs for road transport. The Norwegian study report stresses that the model is a first version and that there is still a high degree of uncertainty attached to the model calculations including the cost functions. However, the report also concludes that, despite these uncertainties, network models of this type could be suitable tools to compare different scenarios and roughly evaluating their effects.

Potential Danish application areas

Freight transport models could be more systematically applied to assess the impacts of extending the Danish motorway network, the modernisation and electrification of the Danish main railway network, and changes of the competition and services of major ports and ferry routes.

The border-crossing transport networks are particular issues for modelling, ref. the Norwegian network model. In this case the transport models should be able to estimate the effects of network changes on traffic and transport flow pattern. Furthermore, these results could provide a basis for assessing the impact on environment and regional development. Examples of cross-border regional concepts that could be relevant for strategic freight transport modelling are the south-western part of the Baltic Sea area, the Oresund region, and the Skagerrak/Kattegat sea area.

Macro modelling structure

Macro modelling of freight transport involves transport demand data for several components of the sequential modelling steps. These data relate to the socio-economic potentials of a particular zone, trade patterns between the zones, indicators of goods flows between the zones, modal distribution of the flows, and assignment to the transport network. The latter component also has to consider the conversion of transport flows to traffic flows. As a consequence the traditional transport macro modelling includes the following sequential steps: 1) generation and attraction of flows based on a selected zoning system; 2) distribution of flows between the zones; 3) modal choice; and 4) route assignment and traffic conversion.

Some particular problems relate to the establishment of an OD-matrix during the first two sequences, to the modal choice including the consideration of intermodal chains and transhipments, and to the assignment sub-models.

OD-matrices (e.g. one for each mode) could be established describing an existing situation, provided the ideal and rather hypothetical situation that exhaustive data are available to describe the relevant transport flows. Such OD-matrices of the existing situation could form the basis for a study of cause-effect relations between socio-economic variables and transport flow variables. Forecasts could then be based on combining such relations with socio-economic scenarios that describe alternative future situations.

The various sub-model types and algorithms, which are available and applied in strategic models, will not be addressed in this paper, as the aim of the paper is to focus on statistical data and requirements. The trade flows between the model zones in question constitute the core information, as a basis for establishing an OD-matrix of freight transport flows.

Micro models ("operational models")
Models that depict the transport system or part of it at the micro-level are termed micro models or operational models.

Operational modelling is potentially useful for the planning and decision-making by individual shippers and transport operators. Operational models could be applied in micro model simulation, including behavioural models and urban logistics. In this case there is a particular need to develop new modelling tools and algorithms.

At the operational level a multitude of data is available. Information could be extracted from forwarding notes and consignment letters, and information about operational costs is available for the different transport modes. The potential availability of data means that models applied at the operational level can be developed to reflect the specific questions of interest.

Research has been carried out at the operational level in order for the transport operators to establish routes for the collection and distribution of goods. An aspect, that has become increasingly important, is the current use of the vehicles during operations by means of mobile phones and satellite positioning. Consignments can be picked up during an empty haul and delivered with a minimum of extra driving.

1.3 Data sources

The general approach of modelling in relation to data requirements should be pragmatic and practical, assuming that in the very short term the quality of available statistics will not improve.

The general categories of information include:
- trade statistics in value and volume/weight terms (ref. NST/R in Chapter 2);
- transport flow quantities (mainly net or gross weight indicators);
- distribution on bulk and various loading unit types (container, swap body, semi-trailer etc.);
- transhipment and transport chain information;
- traffic volumes and composition on routes and through nodes and terminals.

The major data source groups are:
1) the foreign trade statistics reported through INTRASTAT and EXTRASTAT (see Chapter 4);
2) date catch of information concerning goods flows, transport units and traffic in terminals, railway stations and sea ports;
3) counting of traffic flows on the road network;
4) periodic surveys, e.g. to provide O/D information about specific transport and traffic flows;
5) operational data extracts.

Any *upgrading of the intra-EU trade statistics* concerning data on modal distribution has to be resolved at the EU level. However, a solution is not foreseen in the medium term. In the meantime, available input data for modelling has to be supplemented by ad hoc OD-surveys, and by a more systematised collection and sorting of the present statistics on freight traffic and transport flows. In this context, a main focus should be on developing a better linking of transport flow data and foreign trade statistics.

1.4 EU research activities

The lack of solid transport data have been dealt with in a range of different research projects, in communications from the European Commission, and in the future data collection strategies formulated by the Danish statistical office ("Statistics Denmark").

The specific research programme for transport within the EU Fourth Framework Programme for Research and Technological Development (FP4) and other initiatives have launched a range of project and activities that are relevant to freight transport statistics and modelling. Among those particularly focusing on transport statistics are:

CONCERTO	Concerted Action Committee on information systems.
GEOSYSTRANS	Geographical database on European transport.
INFOSTAT	Information systems and statistics for strategic transport planning in Europe.
MESUDEMO	Methodology for establishing general databases on transport flows and databases on infrastructure networks.
MYSTIC	Methodology and evaluation framework for modelling passengers and goods on transport infrastructure scenarios.
REDEFINE	Relationship between demand for freight transport and industrial effects
TRILOG	Overview of global supply chain management.

Below the findings of these projects of relevance to goods transport data are commented briefly upon.

CONCERTO
The concerted action is an on-going activity initiated by the EC and with the participation of Eurostat. It consists of regular meetings with representatives of the Member States, in order to compile and co-ordinate the research activities related with European transport information. CONCERTO is served by a secretariat.

GEOSYSTRANS
This project has concentrated on developing a methodology for the establishment of a main framework regarding demographic and socio-economic data in a European spatial context. Thus the project mainly relates to the group of data influencing transport demand and not directly to transport flow data.

INFOSTAT
The aim of the *INFOSTAT* project was to identify the ideal requirements of a new European Transport Policy Information System (ETIS) considered as complementary to national transport statistical systems. The project was finally reported in 1998, and recommendations concerning some key requirements of relevance to national goods transport data are presented below.

Cooperation and concerted actions with national administrations is found to be essential for the success of ETIS. It should be guided by a number of principles summarised as follows:

- *"ETIS definitions and architecture should minimise the needs for the Member States to change definitions used by their national information systems.*
- *As data needs and requirements at the EU transport policy decision-making level will change continuously over time, a different approach to data collection and processing may be considered, e.g. based to a larger degree on ad hoc surveys*"
  (INFOSTAT, 1998).

INFOSTAT recommends that the spatial concepts of ETIS should be embedded in a flexible zoning system. Spatial movements should be described by means of quantitative indicators of both transport and traffic (vehicle movement) flows.

MESUDEMO
The *MESUDEMO* project was under completion in year 2000. The aim was to follow up on the conceptual definitions, elaborated by the INFOSTAT project, with practical and realistic proposals for the operational contents of the concepts, and with a view to implementation. A preliminary deliverable report about "identifying data on goods and passenger flows" was issued in August 2000.

The background for the INFOSTAT and MESUDEMO projects is that current statistical practices of most countries lack the European dimension. As a consequence, there is a need for national efforts to extend the geographical scope of data collection, in order to cover border-crossing flows and produce O/D information for such flows.

The need for a future ETIS is supported by the following quotation from the report:

> *"All over Europe central and local governments, institutions, businesses and citizens every day make transport and transport motivated decisions: where to go and how to get there, what to ship and whereto, which transport modes to use, and where to locate facilities and make investments. Transportation constantly responds to external and internal forces such as individual and collective preferences, market conditions, population patterns, safety concerns, weather conditions, and energy and environmental constraints. Good decisions require having the right information in the right format at the right time. Relevant information about goods transport, passenger travels and transport mode use is basic for understanding the transport demand"* (MESUDEMO, 2000).

The requirements of a transport policy information system are that the concepts used are appropriate, that there is a match between concepts, operational definitions and measurements, that information is at the appropriate level of detail, and that the statistical information is timely.

The objectives of the part of the project addressing data on goods and passenger transport flows to be included in ETIS were formulated as follows:

- Definition of the indicators and the variables relevant for European transport flows.

- Identification of the harmonisation procedures that will be needed in each country, in order to ensure that the indicators and the corresponding data can be brought together in a system leading to one database.
- The methodology recommended should lay the foundation for a consistent transport chain database.

Based on a pilot study (TRANSITIE) in the Netherlands, it is concluded that:

> "*After the disappearance of the European inner borders the quality of import, export and transhipment statistics has deteriorated extensively….If no action is being undertaken the quality of the statistics will get worse rather than get better*" (MESUDEMO, 2000).

A general conclusion is that the lack of more detailed O/D information is one of the major shortcomings of the existing transport statistics. Traditional statistical data on European transport flows are mostly restricted to uni-modal registration at an annual basis of tonnes and tonne-kilometres that are broken down by commodity group. The geographical specification is confined to the country of origin and country of destination (NUTS 0 level, see Chapter 2).

The aim is to build a harmonised database that gives sufficient insight into goods transport system performance. In this relation, a main conclusion from the establishment and harmonisation of the ATIS database (Alpine case study) was that it is more efficient to aggregate databases from different sources than to rely on one single source/database.

MYSTIC
This FP4 project concerning a methodology and evaluation framework for modelling has not yet been finally reported (2000). Originally it included a component on goods transport, but the main focus has been on passenger transport.

REDEFINE and TRILOG
These two EU supported research projects were finally reported in 1999. They do not contribute with any specific conclusions on modelling structures and data collection. However, the two studies identify some policy issues and trends in freight logistics that should be considered by the future freight transport databases and modelling.

The REDEFINE research consortium consisted of partners from the Netherlands, Sweden, UK, France and Germany. The main focus of the REDEFINE study, which included the mentioned countries, was to analyse the relationship between economic activity and road freight traffic. This involves the question about how much of the growth of lorry traffic is a function of economic growth and how much is attributable to logistic changes.

The specific objectives of REDEFINE was:
- to model the factors affecting the increased demand for road freight, and relationships between these factors and changes in industrial and logistic structure;

- to develop strategies to manage and improve road freight transport and logistics in order to reduce or arrest the negative externalities caused by transport;
- to forecast the effectiveness of alternative policies, and where such policies might fit into the comprehensive transport strategy of governments.

The results of the analysis indicated that:

> "*an increase in the average length of haul is the single most important contributor to increased road freight transport demand*", and that the increased "*average length of haul has led to a significant growth in vehicle km over and above the growth in production"* (REDEFINE, 1999).

The major factors contributing to this trend are the spatial concentration of production and inventory, wider geographical supply and distribution, and the concentration of international trade on hub ports.

The study analyses the logistic trends in more detail, with a focus on supply chains, and discusses a number of policy measures and their likely effectiveness to reduce the externalities of road freight transport.

The TRILOG research consortium was represented by the same countries as REDEFINE and with a couple of overlaps of specific partners.

Focus of the study is on the Supply Chain Management (SCM) concept, and the related prospects of intermodal transport in Europe. The summary report points out some interesting development trends in logistics and freight transport that is of particular interest for the development of the transport industry.

The particular conclusions on intermodal transport are that the market share in the EU is limited to 7.5%, but it has shown a considerable growth; and that in some EU regions, the geographical and infrastructure constraints determine the modal choice.

The TRILOG report finally advises that indicators and data in order to monitor the developments (on logistics and SCM) are lacking, and that the collection of data at the "meso" (branch) level may be facilitated by the current ICT developments.

2. EU CLASSIFICATIONS

The first part of this chapter provides some considerations about the zoning system to be used for statistics and modelling. The second part gives a presentation of the EU classification of trade statistics.

2.1 Geographical representation and zoning system (NUTS)

The spatial O/D dimension has to apply a geographical unit concept such as “area”, “region”, “territory” or “zone”. Transport modelling uses the “zone” concept, and the location of the zone is defined by the co-ordinates of its “centroid”. Several types of statistical information can be attached to the centroid of a zone, e.g. figures of population, income, car ownership etc. In principle, O/D information about transport flow volumes could be linked to explaining variables attached to the centroids of the zones.

In principle, the geographical division into the zoning system of a transport model should be based on functional criteria. However, for practical reasons it is feasible to base the zoning on the administrative boundaries and areas of each country, as the national statistics follows these administrative units.

The NUTS zoning system

The Eurostat operates with a standardised zoning system, the NUTS zoning, which is a five- to six-level hierarchical classification. In most cases the NUTS zones are delimited by the existing administrative boundaries applied by each country. The NUTS system is specified for several levels of territorial aggregation. At the NUTS 0 level, the zone is equal to the territory of the national state. Figure 2.1 shows the zoning at the NUTS 1 and NUTS 3 levels.

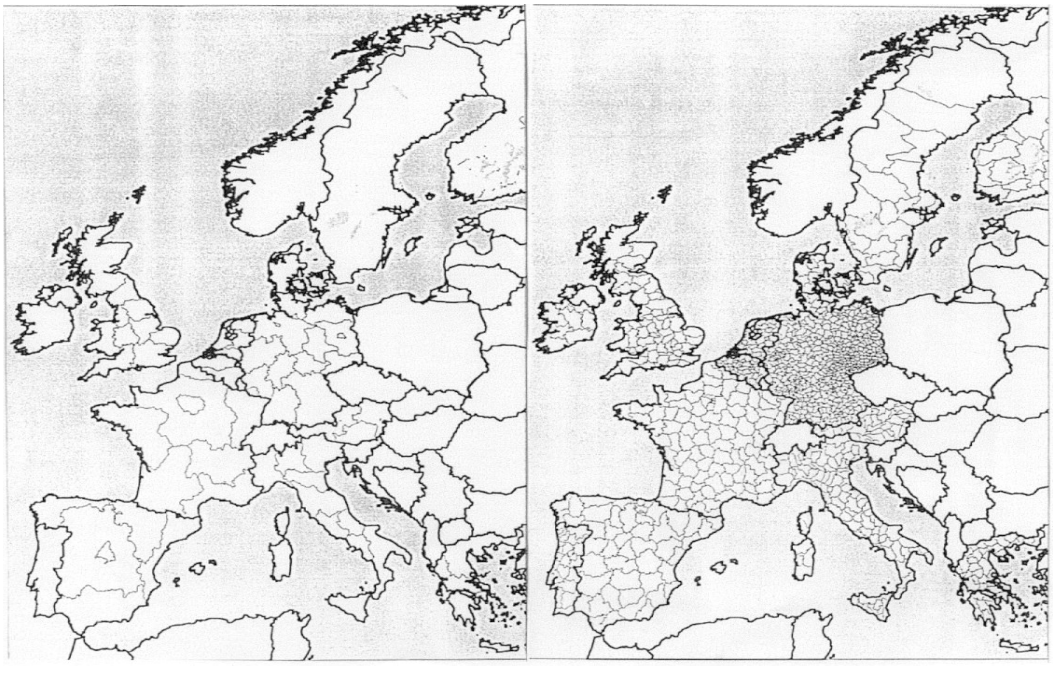

Fig. 2.1: The NUTS 1 and NUTS 3 zoning levels *(source: Eurostat/NEA)*

For some small countries such as Denmark, the NUTS 1 and 2 level zones are not required. As for Denmark, the counties (until 2007) were defined as NUTS 3 level zones and the municipalities as NUTS 5 level zones. Sweden is represented also by eight NUTS 2 level zones that are geographical aggregates of 2-5 counties each.

Due to the differences between the administrative classifications of the various countries in Europe, the size of zones at each level varies considerably from country to country. As an example, the largest NUTS 2 level zone in Spain is larger than the whole of the Netherlands.

In the case of Germany, each zone at the NUTS 1 level covers the territory of one of the 16 states ("Länder"), and the NUTS 2 level zones consist of 40 "Regierungsbezirke". The NUTS 3 level zones of Germany ("Kreise") and of the Benelux are much smaller than the similar zones of neighbouring EU countries.

NUTS 3 provides a sufficient level of accuracy and detail in most cases, and several countries have chosen to develop their national transport planning models at the NUTS 3 level. In practice, NUTS 2 is considered the most realistic zoning level for statistics and models involving more countries, given the present state of affairs for transport statistics (MESUDEMO, 2000). However, at present not even a complete O/D matrix is available for European goods transport at the NUTS 0 level.

Goods transport statistics compiled by Statistics Denmark are available at least at two geographical levels, i.e. the country as a whole (NUTS 0) and the county level (NUTS 3). Particular data on goods transport are related to a more specific geographical location, e.g. port statistics by each port. In general the national transport statistics can be broken down into the county and municipality levels, whereas statistics on international transport in most cases cannot be broken down at any geographical level below the country level.

The communication from the European Commission (EC) concerning the collection of road goods transport statistics, COM(97) 443, suggests that future statistical data about national and international goods transport by road will be based on the NUTS 3 geographical zoning. This implies that the Danish counties (until 2007) would be the geographical basis for future transport statistics. Such a zoning level is appropriate and consistent with the socio-economic data presentation that follows the administrative boundaries of the counties.

To the extent that demographic and macroeconomic variables and other external indicators are provided at the Danish county level (until 2007) or at a similarly aggregated geographical level, this degree of geographical detail suffices, except for micro modelling and for urban and local macro modelling.

As for the zoning of neighbouring EU countries, the NUTS 2 level appears as sufficient in most cases. However, the request of the EC to carry out data collections at the NUTS 3 level makes it possible to aggregate geographical zones to the geographical detail required in the particular modelling case. The NUTS 3 level zones for Germany constitute, as mentioned previously, much smaller geographical units than the Scandinavian counties that are also defined as NUTS 3 zones, and the former should be appropriately aggregated.

2.2 CTSE and NST/R nomenclature for commodities

The “Commodity Classification for Transport Statistics in Europe” (CTSE) is a common nomenclature established by the United Nations’ Economic Commission for Europe (UN-ECE) situated in Geneva. CTSE is based on 20 Categories, 52 Divisions and 169 Positions; these are related to the “Standard International Trade Classification” (SITC) used by the UN.

The “Nomenclature Uniforme des Marchandises pour les Statistiques de Transport” (NST) is a commodity classification for transport statistics used by the EU. Experts from the Member States and the European Commission established the nomenclature in 1961. Since a revision in 1967, it has been indicated as NST/R. The purpose was to set up a uniform goods classification system applicable throughout the EEC, and the nomenclature is based on the CTSE classification.

The national transport statistics based on trade data have been using the CTSE and the SITC nomenclatures. The NST/R classification has also been registered for each dispatch in the statistics, but the NST/R classification was not established with the same precision as the CTSE and SITC goods classification. However, the NST/R classification is used throughout the EU and by Eurostat, and the Danish system has been harmonised with this EU system. Thus the NST/R classification has been applied on a more widespread scale.

The NST/R classification is described by a 2-, 3- or 4-digit code. In the 3-digit code it consists of 10 main Chapters, 52 Groups and 176 Positions. The first digit refers to the main chapter, the second digit refers to the group and the third digit refers to the position. On the position level there is a one-to-one relation between the NST/R and the CTSE. Six positions in the CTSE were, however, subdivided in the NST/R.

The CTSE classification and its conversion to the NST/R 2-digit codes are shown in the table of Figure 2.2.

CTSE	NST/R 2-digits	Description
1	01	Cereals
2	02,03	Potatoes, other fresh or frozen fruits and vegetables
	00,06	Live animals, sugar beet
3	11,12,13 14,16,17	Foodstuff and animal fodder
4	18	Oil seeds and oleaginous fruits and fats
5	05	Wood and cork
6	71,72	Natural and chemical fertilisers
7	64,69	Cement, lime, manufactured building materials
	61,62,63 65	Crude and manufactured minerals
8	41,46	Iron ore, iron and steel waste and blast furnace dust
9	45	Non-ferrous ores and waste
10	04,09	Textiles, textile articles and man-made fibres, other raw animal and vegetable materials
	84	Paper pulp and waste paper
11	21,22,23	Solid mineral fuels
12	31	Crude petroleum
	32,33,34	Petroleum products
13	83	Coal chemicals, tar
14	81,82,89	Chemicals other than coal chemicals and tar
15	95	Glass, glassware, ceramic products
	96,97	Leather, textile, clothing, other manufactured articles
16	51,52,53 54,55,56	Metal products
17	94	Manufactures of metal
18	91,92,93	Transport equipment, machinery, apparatus, engines whether or not assembled and parts thereof
19	99	Miscellaneous articles
20		?

Fig. 2.2: The CTSE classification and its conversion to NST/R 2-digit codes

Based on the NST/R-classification, Eurostat has developed the “24 Groups of Goods” applied in statistical publications. These Groups of Goods are usually referred to as NST/R-24. The NST/R-24 grouping of NST/R positions is the basis for road, rail and inland waterway transport statistics published by the Eurostat.

The relationship between the NST/R 2-digits classification and the NST/R-24 is shown in the table of Figure 2.3.

EUROSTAT Groups of Goods		
Groups of Goods NST/R-24	**NST/R 2-digits**	**Description**
1	01	Cereals
2	02,03	Potatoes, other fresh or frozen fruits and vegetables
3	00,06	Live animals, sugar beets
4	05	Wood and cork
5	04,09	Textiles, textile articles and man-made fibres, other raw animal and vegetable materials
6	11,12,13,14,16,17	Foodstuff and animal fodder
7	18	Oil seeds and oleaginous fruits and fats
8	21,22,23	Solid mineral fuels
9	31	Crude petroleum
10	32,33,34	Petroleum products
11	41,46	Iron ore, iron, steel waste and blast furnace dust
12	45	Non-ferrous ores and waste
13	51,52,53,54,55,56	Metal products
14	64,69	Cement lime, manufactured building materials
15	61,62,63,65	Crude and manufactured minerals
16	71,72	Natural and chemical fertilisers
17	83	Coal chemicals, tar
18	81,82,89	Chemicals other than coal chemicals and tar
19	84	Paper pulp and waste paper
20	91,92,93	Transport equipment, machinery, apparatus, engines - whether or not assembled - and parts thereof
21	94	Manufactures of metal
22	95	Glass, glassware and ceramic products
23	96,97	Leather, textile, clothing, other manufactured articles
24	99	Miscellaneous articles

Fig. 2.3: Relations between NST/R-24 and NST/R 2-digit codes

In sea transport databases, a drawback is that containers, ro-ro units and barge transport are practically always categorised by the NST/R 4-digits code 9990 that is included in the NST/R 2-digits code 99: “miscellaneous articles” (ref. MESUDEMO, 2000).

2.3 The NST-2000 outline proposal

In 2000 the NST nomenclature was being discussed with the purpose of designing a new NST-2000 nomenclature, which better fits the present needs of transport statistics. There are a number of other reasons for reconsidering the nomenclature.

The NST nomenclature was designed with reference to the trade nomenclature of NIMEXE. However, the latter was replaced by the CN (Combined Nomenclature) also applied in Denmark. There are no direct links between the CN and NST.

The NST groups are not considered as adequate, and the number of groups in the NST/R-24 is too large for practical purposes.

The EC has decided that all goods classification systems should be linked with the economic activity expressed in the "Classification of Products by Activity" (CPA) nomenclature. As a result, the NST-2000 proposal is a completely new commodity classification system with strong links to the trade flows following the CPA classification.

A preliminary proposal for the NST-2000 classification is presented in the table of Figure 2.4. The composition of some of the groups is still under discussion, and further modifications are expected (December 2000).

NST-2000 Group	Short description	CPA-code description and/or other description
01	Agricultural products	A: Products of agriculture, hunting and forestry B: Fish and other fishing products; services incidental to fishing
02	Coal, crude petroleum	C: Products from mining and quarrying
03	Metal ores	
04	Food, beverages, tobacco	DA: Food products, beverages and tobacco
05	Manufactured products: Textiles, leather, and related products	DB: Textiles and textiles products DC: Leather products
06	Wood and products of wood and cork	DD: Wood and products of wood and cork DE: Pulp, Paper and paper products, recorded media; printing services
07	Refined petroleum products	DF: Coke, refined petroleum products and nuclear fuel
08	Chemicals, chemical products, rubber and plastic products	DG: Chemicals, chemical products and man-made fibres DH: Rubber and plastic products
09	Other non-metallic mineral products	DI: Other non-metallic mineral products
10	Basic metals, fabricated metal products	DJ: Basic metals, fabricated metal products
11	Transport equipment	DM: Transport equipment
12	Furniture, other manufactured goods N.E.C.	36: Furniture, other manufactured goods N.E.C.
13	Manufactured products: Machinery and electronic products	DK: Machinery and equipment N.E.C. DL: Electrical and optical equipment
14	Secondary raw materials, municipal wastes and other wastes not specified in the CPA	37: Secondary raw materials Municipal wastes and other wastes not specified in the CPA
15	Mail, small parcels	Normally used for goods transported by postal administration and specialised courier services
16	Equipment and material utilised in the transport of goods	Such as: empty containers, palettes, boxes, crates, roll cages
17	Grouped goods	**NB! The groups 17-19 were still under discussion in 2000**
18	Unidentifiable goods	
19	Other goods	

Fig. 2.4: The NST-2000 outline proposal

The NST-2000 is simpler than its predecessor. It has been important to define a limited number of groups, which were adequate in size in order to avoid problems of representation. NST-2000 consists of only 15-19 groups and with no division into subgroups. The intention is to use these groups both for the exchange of statistics between various EU bodies, to include the Accession Countries in this exchange, and to use the groups for the general dissemination of statistics.

Remarks to the NST-2000 classification

The problem of discontinuity with regard to the existing statistics is evident. However, the NST-2000 proposal indicates that it is possible to establish reasonably accurate methods in order to convert existing statistics to the new classification system. This conversion will be necessary in order to avoid the loss of an immense data source depicting the last 20 years of development and trends in goods transport.

In principle the linkage between the NST-2000 and the CPA is very appropriate for modelling, as it might facilitate OD-zoning inputs concerning production potentials that are consistent with the goods transport flows.

As mentioned above, an important criterion for the design of the NST-2000 is that it should always be possible to determine to which group a certain commodity belongs, based on the activities that produce it. However, some special groups are included in the NST-2000 proposal as well. These deal with specific types of goods, which are either difficult to classify according to activity (e.g. loads organised in containers), or do not appear as a trade commodity (e.g. transport of solid waste), or they are not linked with a production activity (e.g. transport of empty containers for repositioning).

It should be clarified to which extent a conversion can be made between the SITC and the NST-2000. There is also a need to look into how the NST-2000 classification groups correspond with the logistic family concept.

As experienced by the Dutch TRANSITIE pilot study under the MESUDEMO project, a large share of containers, ro-ro units and barge transport in export are presently nearly always indicated in the national sea transport database under the NST/R 9990 group. A similar experience was pointed out by the REDEFINE project. In its list of recommendations is raised one point related to the NST/R 99 goods classification, i.e. a suggestion to split the “miscellaneous articles” into sub-classes, as this class currently accounts for approx. 25% of all road freight activity. The mixed and aggregated characteristics of this class make it difficult to identify the logistic trends embedded in it.

Containerisation is envisaged to increase and to include a growing share of goods from some of the other NST groups. In principle the process sequences are: 1) the manufactured goods (or provided services) to be consigned; 2) the choice of transport loading unit (e.g. bulk, liquid, tanker, container, swap body, trailer, ro-ro etc.); and finally 3) the choice of mode and/or chain of transport. There are even examples where break-bulk is being containerised.

These reasons are contributing to the still pending definition of the groups 17-19 under NST-2000. It will probably take a few more years, before Eurostat will be able to implement the new NST-2000 classification as described above.

3. FINDINGS OF THE INFOSTAT AND MESUDEMO PROJECTS

This chapter presents the main findings and recommendations of the INFOSTAT and MESUDEMO projects, with a particular focus on statistics and data record structure for freight transport demand indicators.

The INFOSTAT research project has presented a “shopping list” of recommendations, and the MESUDEMO project has further elaborated on the issue with the aim of practical applications. The findings of the two EU research projects could form a preliminary framework for a gradual introduction of improvements and international harmonisation of national databases.

3.1 Recommendations by INFOSTAT

The situation and relevance of existing data has been assessed by INFOSTAT. The project points out that satisfactory data sources already exist for all EU countries in order adequately to describe the following fields:

1) Topographic and land-use data. These are normally available at the NUTS 2 level with GISCO as the appropriate source. However, main demographic and economic indicators are available mostly at country level (NUTS 0) only.
2) Detailed physical and operational transport network characteristics. These transport supply data are available for most countries both in national and international databases.

As for global indicators of goods transport demand, such as tonnes and tonne-kilometres broken down by mode and commodity group (according to the NST classification), it is possible only to get data of reasonable quality at the NUTS 0 level.

The INFOSTAT review has identified the following main gaps and deficiencies concerning data related to goods transport:

- No coherent data exist on OD flows at the European level. INFOSTAT concludes that:
  “Here the absence of transport chain information is a very important gap in policy decisions. Other deficiencies are the lack of transit flows, and the non-existence of appropriate data on intermodal and dangerous goods transport in Europe” (INFOSTAT, 1998).
- INFOSTAT states that data on combined transport infrastructure (including necessary mobile equipment) are missing.
- No database on transport prices has been identified at the multinational level (except for air transport), and no systematic collection of reliability indicators has been established.

The INFOSTAT reports conclude that a future ETIS cannot be fed more or less directly from existing databases, and it is recommended that additional efforts will be necessary in three different fields:

- *“Harmonisation procedures for building ETIS indicators on the basis of existing data.*

- *Co-ordination of ETIS standards and Statistical Directives at the EU level.*
- *Complementary data collection or changes in the data collection to be initiated in the long term*“ (INFOSTAT, 1998).

The availability of indicators, in the sense of harmonised and coherent data for all EU Member States, are usually restricted to the country level (NUTS 0 level), as EU policy was initially geared to the supra-national level. The transport statistical system has not kept pace with the requirements of broader policy approaches including cross-border regions of Europe and trans-European networks.

Although the concept of intermodality has been given a high policy priority in recent years, a common definition of intermodal transport has not yet been accepted. The INFOSTAT project concludes that:

> *“The current philosophy of statistics is still mode-based, neglecting the empirically and politically desired integration of single modes into intermodal networks, and more generally a complete view of the chain of transport from the region of production to the final destination of the goods. Special attention has to be devoted to the transfer points and links between modal networks*” (INFOSTAT, 1998).

Following the introduction of the Single Market in January 1993, the traditional customs based statistics for modal distribution of internal EU trade was abandoned and the available database smouldered. At the same time relevant data have become more urgent. This is due to the growing policy needs, transport modelling needs, and the needs for monitoring of the drastically changed trade flow pattern between Western and Eastern Europe following the commercial integration since 1989. As a result, there is an acute need for both interregional and international OD matrices.

INFOSTAT recommends that immediate actions should be taken in order to provide:

- OD transport chain matrices for the various transport modes and commodity groups at defined NUTS levels;
- insight into causal mechanisms relating to goods transport;
- linkage between goods transport and goods traffic;
- revitalised data reporting procedures.

INFOSTAT also suggests some immediate actions to be taken concerning *intermodal transport*. This includes that the EC (Directorate General for Transport and Energy, DG-TREN) and EUROSTAT should study the Statistical Directives with a view to intermodal transport in the following directions:

- the scope for compiling intermodal transport data from railway companies and shipping companies should be looked into;
- a European-wide region-to-region transport chain database, including chains of up to two transhipment points, should be developed;
- the development of telematics (e.g. within tracing and tracking) together with traffic counts could have a potential for supplying information about intermodal transport.

As already mentioned, a future ETIS is to be considered complementary only to national statistical systems. However, for this purpose INFOSTAT advises that it might be necessary to ensure a certain degree of standardisation and harmonisation between national databases.

3.2 Indicators suggested by INFOSTAT/MESUDEMO

The INFOSTAT project suggested the grouping of statistical indicators that is presented in Chapter 1, including a group of transport demand indicators.

The MESUDEMO has specified six goods transport demand indicators, out of which four are considered as fundamental. The indicators, which have to be regarded as the desired end-result of a transport policy database, are presented in the overview table of Figure 3.1:

No.	Variable label	Unit of Measurement	Observational Unit	Priority Level
1	Total annual goods transport flow between the zones - by commodity group, mode (or combination of modes) and type of transport chain	tonnes/year	O/D pair	fundamental
2	Average distance between origin and destination of the transport unit - by mode	km	O/D pair	fundamental
3	Average distance between origin and destination of the goods – broken down as for indicator 1	km	O/D pair	fundamental
4	Loading factor (ratio between volume and capacity) per type of transport unit - by mode	percentage	O/D pair (main leg)	desirable
5	Annual total number of tonnes transported - broken down by: - size of load/consignment (weight) - value of load/consignment (euro) - trip distance (km) - containerisation (yes or no) - type of transport unit	tonnes/year	O/D pair (main leg)	fundamental
6	Average number of hours of use of the transport unit	hours/year	zone	desirable

Notes:
1) Tonne-kilometre figures can be derived by multiplying the tonnes/year and distance between O/D pairs.
2) It might be considered to present the value flows in the same spatial and modal details as volume (in tonnes) flows

Fig. 3.1: Goods transport demand indicators

A similar table has been presented by INFOSTAT for *goods transport services*, in which case a modal breakdown is suggested on road, rail, air, waterway and intermodal transport. The main variables of transport services include transport time (between origin and destination), transport price per tonne-kilometre by commodity type, service frequency and cost components (fixed, variable).

The projects recommend a policy oriented and comprehensive database, keeping the following aspect in mind when aggregating the linked transport information:

- A harmonised classification should be introduced to be able to ensure that the most discriminating information is included, e.g. the classes to be used for indicating the weight or value of the consignment.
- Individual items should be counted in new variables, e.g. number of trips, number of consignments, etc.
- Some additional variables should be calculated, e.g. weight multiplied by distance of shipment in order to derive at tonne-km figures, and capacity multiplied by (loaded and/or empty) trip distance, etc.
- Consistency with the classification used in trade databases for building transport chains.
- Consistency with the classification used in other parts of a future European transport information system (socio-economic data, passenger flows, infrastructure links and nodes, impacts).

Furthermore, the MESUDEMO project elaborates on the INFOSTAT project proposal, and presents the following specification and modification of each indicator for practical applications and modelling purposes.

<u>Indicator 1 (goods transport flow volumes between zones)</u>
The "original" origin and the "final" destination of a transport chain should indicate some original and final activity respectively, e.g. production processing. The transport chain specification is discussed in section 3.3.

<u>Indicator 2 (average distance of transport unit)</u>
The origin and destination of the transport unit are not always the same as the place of loading and unloading of the goods during the trip.

The transport performance figures in tonne-kilometres only include the loaded kilometres of a trip, whilst vehicle-kilometres include both loaded and empty vehicles.

A complete presentation of this type of indicators in the database record structure could be as follows:

1. *Zone of loading of the transport unit*
2. *Zone of unloading of the transport unit*
3. *Transport mode*
4. *Transport unit*
5. *Weight (in tonnes) transported*
6. *Transport performance in tonne-kilometres*
7. *Average distance in kilometres (= 6/5).*

<u>Indicator 3 (average distance between origin and destination)</u>
For a transport chain involving one transhipment only, the average distance could be represented as follows in the database record structure:

1. *Zone of <u>original origin</u> of the goods flow*
2. *Zone of <u>final destination</u> of the goods flows*
3. *Zone of transhipment*
4. *Mode used from original origin to node of transhipment*
5. *Mode used from node of transhipment to final destination*
6. *Weight (in tonnes) transported*
7. *Transport performance in tonne-kilometres*
8. *Average distance in kilometres (= 7/6).*

Indicator 4 (loading factor)

The capacity of a transport unit can be specified in various ways, for example as weight carrying capacity, volume carrying capacity, and capacity in number of units.

A database record for the loading factor could be specified as follows:

1. *Zone of loading of transport unit*
2. *Zone of unloading of transport unit*
3. *Mode of transport*
4. *Transport unit*
5. *Weight (in tonnes) transported*
6. *Carrying capacity (in tonnes) moved*
7. *Loading factor.*

The MESUDEMO report is not clear as to whether a “transport unit” in this particular context is applied according to the ECMT terminology that implies both including vehicles used and equipment, e.g. containers. In this context concerning capacity and loading factors it probably makes most sense to replace “transport unit by “means of transport unit” or “rolling stock”, e.g. truck, train, or vessel. However, the number of empty containers transported is also a relevant figure for the database, as they represent unused capacity often in connection with unbalances between import and export flows.

Indicator 5 (annual total number of tonnes transported)

This indicator provides information about the *main leg* of a transport chain. It is related to the load (consignment) carried by a specific type of transport unit. However, in more complex transport chains it might be arbitrary to choose a certain leg as the main leg.

The indicator is measured in total number of tonnes but could include the total value that has been transported as well. Thus a database record could be represented with the following specifications:

1. *Zone of loading of the transport unit*
2. *Zone of unloading of the transport unit*
3. *Transport mode*
4. *Transport unit*
5. *Load weight class*
6. *Load value class*
7. *Trip distance*
8. *Cargo type*
9. *Weight (in tonnes) transported*
10. *Value (in euros) transported.*

The specification in classes - of the load weight, of the value of the load, and the trip distance and cargo type - intends to make a link to the modal choice. It offers the possibility to differentiate e.g. between bulk and general cargo, between liquid and dry bulk, and between loading units such as containers, swap bodies etc.

The use of EDI, tracing and tracking etc. was originally suggested by the INFOSTAT project as a separate indicator. MESUDEMO recommends it to be aggregated to an O/D relation under indicator 5, with perhaps further specification of the type of consignment.

Indicator 6 (average annual number of hours of use)
This indicator intends to describe the availability of the transport unit used. It is considered more adequate to measure it in effective hours rather than in days per year.

The database record structure could be as follows:

1. *Zone of registration*
2. *Transport mode*
3. *Transport unit*
4. *Carrying capacity class*
5. *Number of transport units*
6. *Average weight carrying capacity*
7. *Average number of hours of use per year.*

The reason for including more information about the carrying capacity than the number of hours actually used is in order to make the indicator more supply-oriented.

Levels of data in relation to transport models
In a second phase, the TRANSITIE pilot study, that was carried out under the MESUDEMO umbrella, aims at considering four levels of information to be included in the database structure:

1) transport mode and unit used;
2) trip by the transport unit;
3) load carried
4) transport chain information.

As for levels 1-3, information could probably be acquired at the individual level through transport statistics, particularly in the cases where registration is based on the vehicle or transport organisation, such as the Danish national truck surveys. These levels of information could be compared with the actual situation of a logistics operator:

> *"In planning the consignments they get from shippers, each of these orders should be assigned to one of their transport units to get it from the original origin to the final destination. Big operators running a global (multimodal) network create in fact their own transport chain in choosing the optimal route through their network"* (MESUDEMO, 2000).

In principle, the national statistical organisations could obtain this type of data by means of EDI. However, a conclusion of the MYSTIC project on this topic is that there is still a long way to go before representative statistical figures can be obtained from EDI-equipped companies.

As for the practical way to collect the information, the TRANSITIE study suggests in the short term to provide the information through shippers' surveys, and in the medium or longer term through the EDI systems of shippers and major transport integrators. Through the same process, it is possible also to obtain information about the economic and logistical determinants of transport.

3.3 New concepts

A major aspect is the overall development of the goods transport sector. The data collection procedures still in use have been developed in the past, and thus they reflect some business and logistic conditions (dominated by economies of scale) that differ completely from present and expected future conditions (increasingly reflected by economies of scope). In addition, the establishment of the EU internal market has considerably diminished the possibilities of retaining any adequate data about the modal distribution of trade and transport flows. This accentuates the necessity of identifying some new concepts and approaches in terms of data collection.

The following *new statistical concepts* have been suggested and briefly explained by the INFOSTAT and MESUDEMO projects:

- The transport chain
- Intermodality
- Logistic families
- Transport quality
- Infrastructure and environmental bottlenecks
- The transport corridor
- Advanced accessibility.

The transport chain:
The INFOSTAT project defines a transport chain as:
"*a sequence of transport modes used to carry a certain quantity of goods from its origin to its final destination. Along the chain, one or more transhipments may take place*".

MESUDEMO suggests that a transport chain with one transhipment node could be presented as follows in a database record structure:

1. *Zone of original origin of goods flows*
2. *Zone of final destination of goods flows*
3. *Zone of transhipment*
4. *Mode from original origin to node of transhipment*
5. *Mode from node of transhipment to final destination*
6. *Commodity group*
7. *Weight transported in tonnes.*

It is being realised that more comprehensive types of transport chains will lead to a very complex data structure. This problem is related to several of the indicators in the table above.

Intermodality:
The TRILOG project presents the EC launched definition of intermodal freight transport ("freight intermodalism") as follows:

> *"The optimal integration of different transport modes, enabling an efficient and cost-effective use of the transport system through seamless, customer-oriented door-to-door services, whilst favouring competition between transport operators"* (TRILOG, 1999).

Intermodality is considered a subset of the transport chain concept, as the latter consists of different modes.

Logistic families:
A logistic family is a grouping or classification of commodities, with a view to how they are being handled and transported from a logistical point of view. Thus they are featuring similar logistical requirements, that are more closely related to manufacturing and commercial behaviour, ref. economies of scope. A classification according to such a principle is still at the conceptual stage only.

As an example, the goods in the trailer are assigned to certain commodity groups, which may be quite distinctive in terms of modal choice. Although cereals and fresh fruit are both agricultural products, the logistic demands are quite different. Fresh fruit may have the same transport characteristics as a certain types of paint, which need temperature regulation during transport. The fruit and the paint are therefore in this sense belonging to the same logistic family.

Transport quality:
This concept is described by a set of performance indicators. A Danish research project (the Danish Transport Council, 1997) identified seven quality performance indicators of particular importance, i.e. transport time, reliability, transport frequency, damage risk, access to information system, flexibility of services, and customs services. Other indicators could be added, such as safety and security etc. INFOSTAT suggests including time indicators, reliability, flexibility, qualification, accessibility, control, safety and security.

Infrastructure and environmental bottlenecks:
The MESUDEMO project suggest all national congestion and traffic load data to be processed in a standardised form, in order to reflect the variety of situations at critical periods of the day or year.

Environmental bottlenecks occur where a given link suffers from both traffic and environmental constraints.

Transport corridors:
A transport corridor can be defined as:
“a geographical sequence of strongly interconnected regions”.

This concept bridges the gap between single transport links and whole networks. MESUDEMO advises that it is crucial to identify the *economic* corridors that constitute the sources (origins and destinations) of the traffic that flows through the *transport* corridors.

Advanced accessibility:
This indicator ranks how well a region, a city or another area is connected to the infrastructure network, in terms of centrality and population density etc. As an example, the total road costs required for a European region to cover a market of say 10 million people could be calculated.

Common accessibility indicators for cities and regions should be defined and applied.

4. OVERVIEW OF DANISH STATISTICAL SOURCES

This chapter gives a preliminary overview of Danish statistical sources of relevance to freight transport modelling. The issue of transit flow data is being discussed, and some data constraints and shortcomings are identified and briefly commented upon.

Neither at the national Danish level nor at the EU level is there any agreed set of guidelines or rules concerning the harmonisation and standardisation of transport statistics, except for the zoning and trade commodity classification systems described in Chapter 2.

4.1 Socio-economic statistics

Besides the transport statistical sources provided by Statistics Denmark, some general macro-economic variables, such as GDP, income levels and employment figures by geographical zones, may substitute the lack of direct production figures in order to estimate the generation and attraction by each particular zone.

The ADAM databank
This databank includes the macroeconomic key figures at the country level and as far back as from 1947. A breakdown is provided into 19 industrial branches and 10-15 foreign trade components. Figures are presented both in current and fixed prices. The databank is available as the PC-AXIS programme on a CD-ROM.

Databases on various socio-economic variables
Databases on demographic figures, housing, employment, incomes and commercial companies etc. are available at the county level (NUTS 3 level) and municipality level (NUTS 5 level).

More detailed data extracts can be provided as ordered statistical services.

Regional macro-economic accounts
This statistical source includes some indicators of production and income. It is based on a new national accounting system introduced in 1995, and was first publicised in January 1999. It includes, whenever possible, a regional distribution at the county level of the Danish national account.

The source should be compatible with international statistics. It is publicised annually, and data are included in Eurostat's REGIO CD-ROM.

4.2 Foreign trade statistics

The trade statistics is a major source of data about freight flows between Denmark and other countries. As such it is also a primary source for freight transport modelling.

The foreign trade statistics is based on the data collection via INTRASTAT and EXTRASTAT, see below. Both methods are described in the annual publication "Danmarks varer. Import og eksport".

At the national level this statistics is quite detailed and comprehensive as concerns the breakdown into commodity groups. It includes Danish export and import, and a breakdown on approx. 10,500 different commodities. For each commodity, the geographical distribution on all of the trade partner countries is provided.

The standard publications that cover the foreign trade statistics present some aggregated data as well. The totals are publicised in SITC categories, but at a more aggregated geographical level than the trade partner countries.

Foreign trade figures are presented both in value and in net weight, whilst most sources on transport statistics indicate gross weight figures. A comparison between net weight and gross weight figures is not possible without adding or subtracting the weights of packaging etc.

Detailed and tailor-made extracts from the database are possible as ordered statistical services. Such extracts would be necessary for carrying out in-depth analyses and for specific modelling purposes.

A drawback as concerns OD-information is that the foreign trade statistics does not provide a geographical breakdown into regions of the trade partner countries. As a consequence, trade flows between neighbouring regions separated by a national border, like for instance between the Copenhagen area and Southern Sweden, are not available in the foreign trade statistics.

EXTRASTAT, trade with non-EU countries

EXTRASTAT covers trade with all of the non-EU countries. In this case, the sources are still the customs documents. The breakdown of figures into commodities within the EXTRASTAT trade statistics with non-EU countries is the same as for trade figures based on the INTRASTAT reporting, see below.

As mentioned previously, the statistical figures do not provide any geographical breakdown into regions of the trade partner countries. As to the geographical origin or destination in Denmark, it is possible to a certain extent to distribute the EXTRASTAT trade figures according to the geographical location of the customs office and the border passage location. However, such detailed data extracts require ordered statistical services.

The modal distribution is still available from the EXTRASTAT trade statistics with non-EU countries. These figures are aggregated at the national (NUTS 0) level, but they could be specified at the border passage location as well.

INTRASTAT, trade with EU countries

This reporting method was introduced as from 1 January 1993, following the establishment of the Single Market. Simultaneously, the registration of trade transactions between EU countries, which was previously based on customs documents, was replaced by the INTRASTAT reporting. For Sweden, Finland and Austria this change entered into force two years later, i.e. 1 January 1995.

INTRASTAT is now the common data registration method for internal trade movements between all EU Member States. A breakdown is made on all of the EU partner countries.

The national source is based on reporting from around 10,500 Danish companies. The INTRASTAT declarations are directly transmitted from the enterprises to the national statistical bureau/administration by using monthly recapitulative declarations (MESUDEMO, 2000). A certain number of enterprises representing low import/export quantities are exempted from the obligation to report. The share of trade of these companies is estimated not to exceed 5% of the total intra-EU trade value for each Member State.

Considering the sample size and composition, the INTRASTAT reporting provides reasonably representative figures about the foreign trade flows, and their composition, with other EU Member States at the country (NUTS 0) level. This is, however, not the case with regard to information about the distribution on transport modes, see the following description.

The basis for collection of transport data by the national statistical offices of the EU Member States was drastically changed by the introduction of INTRASTAT. A drawback of the method is that it is not able to provide any reliable data on the modal distribution of trade flows. As a result, adequate information on the modal distribution of Danish international trade flows that cover EU Member States have vanished since the start of 1993. Thus it is difficult to produce any consistent time series of the distribution on transport modes that includes the period before and after the introduction of INTRASTAT.

Until 1996, “Statistics Denmark” continued publishing international transport statistics with a breakdown on import/export, commodity groups and transport modes. However, the figures for modal distribution of trade with other EU Member States became increasingly doubtful. A contributing reason is that in many cases the specific transhipment is passing through a transport chain and it is not adequate to categorise it by a single mode. As an example, INTRASTAT categorised goods transport by ferries as transport by ship, and not according to the mode of transport (e.g. lorries/road haulage) using the ferry service. As a consequence, since 1997 "Statistics Denmark" has ceased to publicise modal information in relation with INTRASTAT statistics, and other EU countries are following suit.

A potential advantage of the INTRASTAT reporting is that it contains rather detailed geographical information about the location of the companies. This information could be more efficiently exploited than hitherto. On the basis of the information about the addresses of the approx. 10,500 companies, it should be possible to allocate the trade flows to a more detailed geographical level of regions or counties in Denmark as the source country. It is not possible to provide a geographical breakdown of these trade flows into regions of the trade partner countries. However, information derived from the INTRASTAT reporting could provide a similar geographical breakdown as to the origin and destination of each particular trade partner country.

Data on interregional trade flows
In order to facilitate freight transport modelling, there is a need to break down the trade flows into smaller geographical units than the country level (NUTS 0 level). The figure 4.1 illustrates the types of interregional flows in relation to two neighbouring countries A and B.

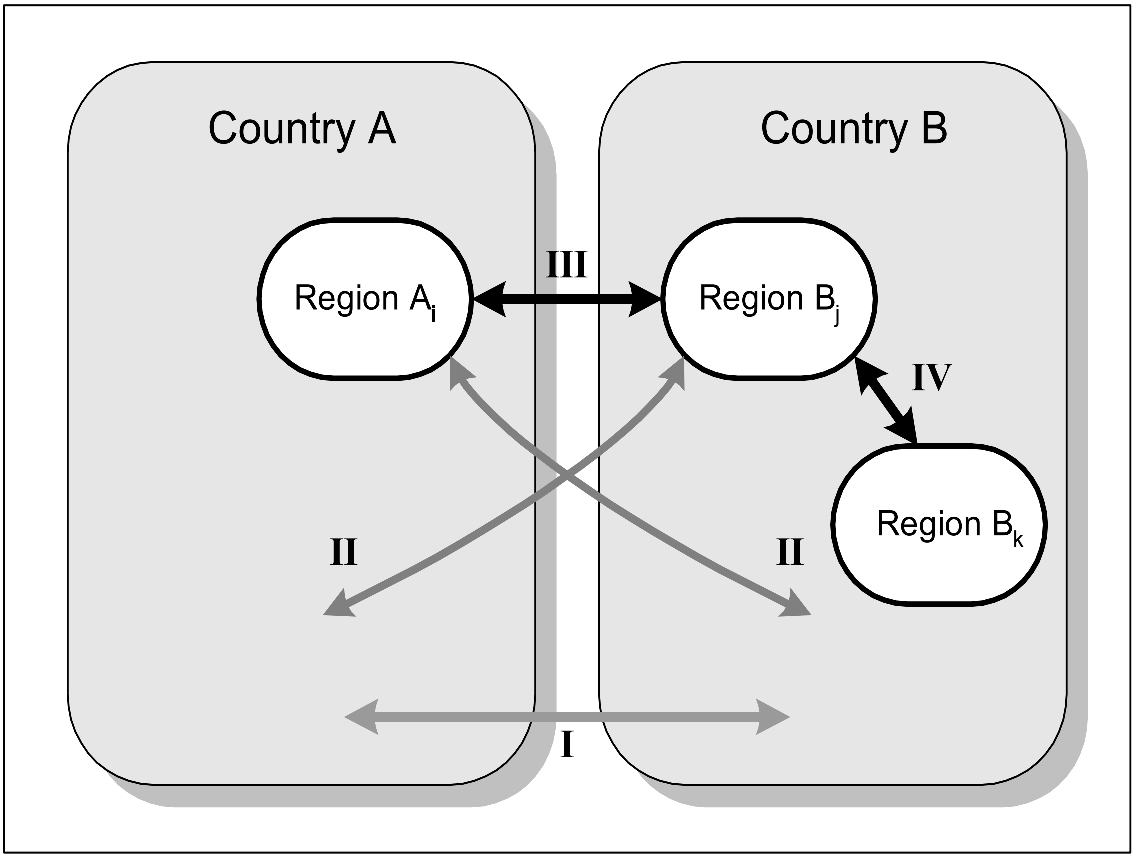

Fig. 4.1: Types of interregional trade flows

The type I flows are covered by the national trade statistics (INTRASTAT and EXTRASTAT).

Statistics for the type IV trade flows, i.e. between administrative regions within a country, has been developed to some extent, e.g. between the counties in Norway. Figures of domestic trade between regions in Denmark are not regularly available. However, various research studies have been carried out, among others by the Danish institutes “AKF” and “Institut for Transportstudier”, to establish a methodology in order to estimate trade flow figures between the Danish counties. A fully transparent methodology has not yet been published, but reasonable estimates of regional trade flows within the country could be elaborated.

As for trade flows between regions located in different countries, e.g. the type III trade flows between regions separated by the borders of two neighbouring countries, the data problem has not yet been solved. One of the major statistical challenges in relation to freight transport modelling is to provide some reasonably reliable estimates of the type III flows.

Within the Intereg IIC Programme (“North Sea Commission”) and the NTN (“Nordic Transport policy Network”) project, a recently completed research study has addressed the question about establishing OD-matrices for goods of the type II trade flows. The study included Danish, Norwegian and Swedish counties or regions located around the Skagerrak and Kattegat Seas. It was reported mid-2000. Trade flow figures were presented for the year 1997, including a breakdown on commodities and modes. A fully developed common methodology for cross-border trade flow between regions in Jutland, Southern Norway and Western Sweden was not presented as a result of the study.

The foreign trade statistics for *Norway* is still fully based on EXTRASTAT, and it also enables a geographical breakdown on each county (“fylke”). Thus it was possible for the study report to present some estimates for each Norwegian county of the import/export trade flows with all of the neighbouring countries and the rest of the World. These were based on studies carried out by the Norwegian Institute of Transport Economics and Agder Research Foundation.

In the case of *Sweden*, it was not possible to provide a breakdown into counties (“län”). Trade flow figures with a few selected European countries were presented for Western Sweden (“Västre Götalandsregionen”). These figures were estimates provided by the EU research project SCANDINET.

As for *Denmark*, the study presented some foreign trade flow figures for Jutland divided into two zones (Jutland North and Jutland South), i.e. a higher geographical aggregation level than the county (“amt”). These estimates were provided by the “Institut for Transportstudier”, based on a study carried out about the commercial and industrial impact of a fixed Fehmarn Belt link.

As mentioned above, the Statistics Denmark has recently started publicising a regional distribution, at county level, of the national account (in terms of production and income indicators). This statistics could form part of the basis for regional trade flow modelling both involving domestic and foreign trade.

Also the studies carried out by the Swedish Institute for Transport and Communication Analysis (SIKA), in order to provide a more detailed geographical picture of commodity flows in foreign trade, are of relevance.

4.3 Mode-specific statistics for Denmark

The existing and most relevant sources of *mode-specified* Danish transport statistics are reported quarterly and/or annually. They cover the following areas:

- Passenger ship and ferry traffic via Danish ports
- Maritime traffic via Danish ports
- Railway transport
- Goods transport carried out by Danish trucks.

These sources are commented briefly upon below. The sources are based on reporting from operators or on regular/annual sampling. They are publicised in “Statistiske Efterretninger” under the heading of “Transport” and in the Statistical Yearbook. Airfreight is not addressed by the present note, as its share is still insignificant compared to other modes in terms of weight/volume. However, the share calculated in value figures is increasing rapidly.

Domestic freight transport routes and corridors

The pattern of transport routes in Denmark resembles both the geographical conditions and the major infrastructure axes, such as indicated by the so-called capital "H" of the motorway network and the main railway network.

The map presentation below indicates the most important domestic freight transport links in Denmark and the major transit routes through Denmark:

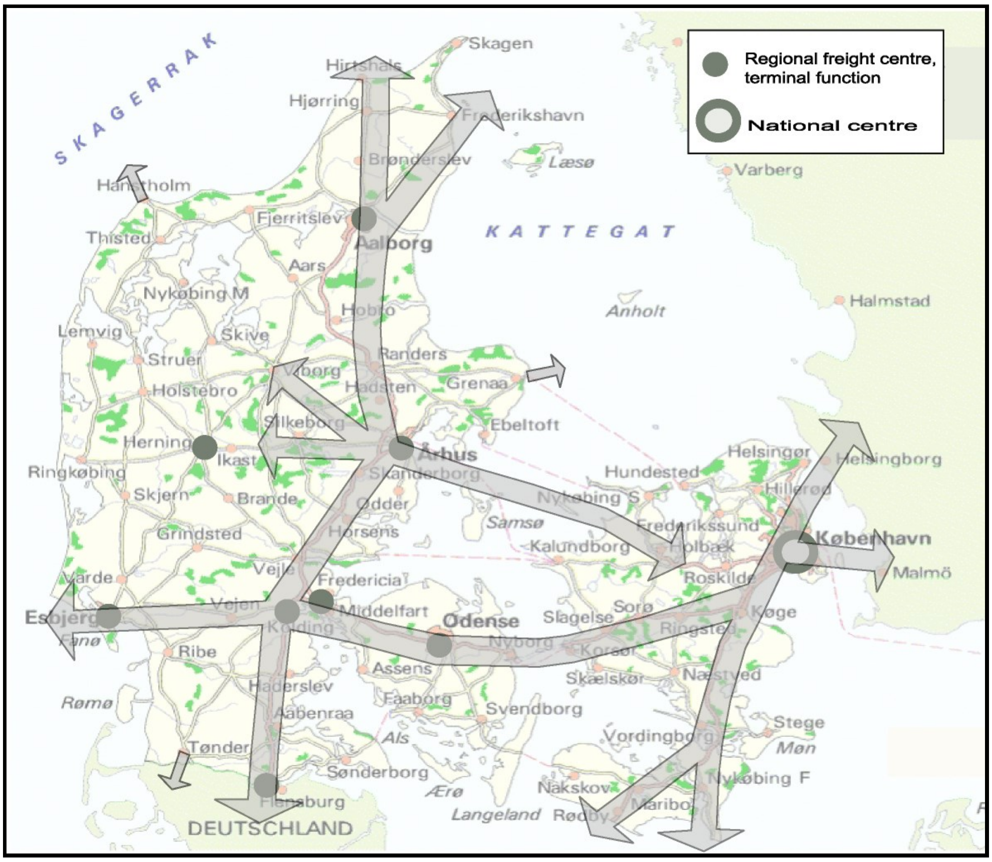

Fig. 4.2: Major freight transport routes/axes in Denmark

The major domestic routes are:

- The Jutland axis running in a south-north direction from the border with Schleswig-Holstein to the international ferry ports in Northern Jutland, which provide connections to Sweden and Norway. The route has a predominantly eastern location through Jutland as it connects the fiord cities from Flensborg via Aarhus to Aalborg. The nodes are located as “pearls on a string”, including Aarhus and the urban “Triangle” area that functions as the connection area with the east-west axis.
- The east-west axis via the Great Belt link and connecting the Copenhagen area with the urban Triangle area. In the west it is extended to Esbjerg Port, with connections to the UK. The external connection in the east is to Southern

Sweden across the Oresund (the Sound) via ferry links and notably via the fixed link that was opened in July 2000.

- The north-south axis from the international ferry port at Elsinore as a connection point to the “Nordic Triangle”, and via Copenhagen to the international ferry ports at the southern coast of Lolland-Falster, with connections to Northern Germany (including the planned location of the fixed Fehmarn Belt link).
- The ferry links across the southern area of the Kattegat directly between Sjaelland (Zealand) and Jutland. These routes have got a troubled competitive position after the opening of the fixed Great Belt link.

The transit freight flows are using both the two north-south axes and the east-west axis, as significant quantities of transit freight passes via the fixed Great Belt link.

The EU funded SCANDINET research project has identified, as important existing corridors for freight transport, the “Dan Link” and “Scan Link” corridors via Copenhagen and Øresund (the “Sound”), and the "Nordic Link" corridor that encompasses the Jutland axis and the ferry links to Norway/Sweden.

Besides these corridor concepts that are mainly land-based, the transit sea routes such as “The Nordic Sea Route” and “The Baltic Sea Route”, which passes through the Danish maritime territory, should be considered as major international transport corridors (SCANDINET, 1999).

Key figures for transport

This publication has been issued annually since 1998 in co-operation between Statistics Denmark and the Danish Ministry of Transport. It provides an overview of key statistical figures aggregated at the national level since 1988, including the modal distribution of goods transport.

Passenger ship and ferry traffic via Danish ports

The publication on passenger ships and ferry traffic is distributed quarterly and provides statistical figures based on monthly reporting by the commercial ferry operators. The statistics is divided into traffic on international routes and traffic on domestic routes. The publication provides traffic figures, i.e. number of ferry trips, number of vehicles served including the distribution on single lorries, trucks with trailers, trucks with semi-trailers, and unaccompanied semi-trailers. However, for some of the ferry routes (e.g. between Hirtshals/Hanstholm and Norway) a breakdown into these categories of trucks is not available.

Railway transport is not included in this publication, but it is specified in the publication on maritime traffic, see below.

A breakdown on direction is not presented in the publication. However, this information is available in the basis material, and it is of particular importance in order to help separating import flows from export flows.

It should be noted that the figures include transit traffic through Denmark.

Maritime traffic via Danish ports

This annual publication on maritime traffic provides a very informative and useful overview of the maritime traffic for each port. It is based on reporting from the ports and the relevant ferry operators.

The publication presents the annual freight transport figures in tonnes on each ferry route, including a breakdown on lorries, railway wagons and miscellaneous. However, it should be noted that the tonnes figures are calculated data that are based on the traffic figures and estimates of average load figures for the trucks.

The present form of statistics was introduced in 1997. It includes, as main variables, the number of ships served (per month; per year only for smaller ports), tonnes of incoming/outgoing freight, and category of commodity.

For each port, a breakdown is provided on major ship types and sizes, on domestic and export/import goods in tonnes, and between in- and outgoing flows in tonnes. Separate total figures are presented for liquid bulk and for ferry freight.

For each port, a geographical breakdown is presented of domestic goods distributed on each Danish county (NUTS 3 level). Export/import figures are broken down into most of the European countries, and into continental regions as for the rest of the world.

The publication specifies the total annual throughput for each port into 21 commodity categories. Five of these can be grouped as liquid bulk, and nine as solid and/or break bulk. The remaining seven categories are wood products, steel and metal products, other general cargo, goods in containers, non-licensed motor vehicles, ferry goods, and other ro-ro goods. In 1998, around 30 Danish ports obtained a total annual throughput exceeding 0.5 million tonnes. However, the 15 largest ports contributed to more than 75 pct. of the overall throughput.

A special overview of annual throughputs, in tonnes and units of containers and ro-ro, is presented for the few Danish ports servicing this type of traffic. The two dominant ports are Aarhus (as for containers) and Esbjerg (as for ro-ro)[1]. These are followed by Copenhagen as the second largest container port, and by the Aalborg port area that is mainly servicing bulk except for the container traffic with Greenland.

As for ferry traffic, a distinction is made between goods by lorries and goods by railways. The DSB ferry service between Nyborg and Korsoer ceased to operate in 1997, when the fixed railway link across the Great Belt commenced its operations. The opening of the fixed link across the Great Belt has also reduced the role of the Roedby-Puttgarden route as regards rail ferry freight. Since 1999, the servicing by Stena Line of railway wagons on the Frederikshavn-Gothenburg route has been insignificant. Only a few railway wagons have been transported by Color Line on the Hirtshals-Norway ferry routes. As from year 2000, rail ferry freight on the Øresund routes have been affected by the fixed link between Copenhagen and Malmoe.

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[1] Statistics reports covering the major ports in countries around the North Sea region suggest how to organise statistics for unitised goods flows via the ports. The reports and statistical tables for the years 2003-2005 can be downloaded from the SUTRANET website: www.sutranet.plan.aau.dk.

Railway transport
This annual publication is based on reporting from the Danish Railway Administration (Banestyrelsen/Banedanmark), The Danish State Railways ("DSB"), and the local railway services providers ("Privatbanerne").

The main part of the publication is occupied by statistics about the rolling stock. As for goods transport, the information provided is limited. Total annual production figures since 1990 are presented in tonnes and tonne-kilometres, and for national, international and transit respectively. For each of these figures, a breakdown is made on general cargo, combined transport cargo (containers, swap bodies, trailers) and full wagon loads (block trains and miscellaneous).

The publication also presents some figures of the daily average number of passenger and freight trains on particular subsections of the railway network. This gives a rough idea of the overall geographical flow pattern.

An OD-matrix is provided of the annual figures (in tonnes and tonne-kilometres) for domestic transport between the counties (NUTS 3 level). It should be noted that the domestic freight transport quantities produced by rail services are relatively modest compared with international rail transport (export/import and transit) and compared with domestic transport by road and sea.

The publication does not provide a pattern of the geographical distribution of the import and export flow figures. The inlets and outlets would notably be the routes via Øresund, Roedby-Puttgarden and Padborg at the Danish/German border in South Jutland. However, since the fixed railway link across the Great Belt was opened in 1997, the freight traffic via Roedby-Puttgarten has been re-routed to pass via Padborg. It would also be relevant to present a breakdown of goods flows on major sections of the trunk network, including flows via the Great Belt link.

As a conclusion, the present railway statistics is insufficient as regards key information about the geographical distribution pattern of the international and transit freight transport flows. However, the Danish State Railways, DSB, may be able to provide such aggregated geographical information, at least since 1997 when its databases were computerised. Further detailed statistics is probably restricted by the DSB for commercial reasons.

Goods transport by Danish trucks
This statistics is publicised quarterly and as a more comprehensive annual publication. The statistics is based on periodic sample questionnaires addressing goods carried by Danish trucks and by means of the driver's logbook (see below).

A drawback as concerns international goods transport by road is that the sample does not include freight transport by foreign trucks. As a result, the picture provided is only partly representative for the overall goods flow pattern by road in Denmark.

These sample surveys are also carried out in other European countries. The survey covers a certain proportion of national trucks above 6 tons that are active in international haulage. Each record in the logbook describes the origin and destination, the amount and type of goods transported, or if the truck was empty during the trip.

Based on these data it is possible to relate the development in road transport of different commodity types with the economic development in different business sectors. However, the sample is relatively small, and therefore the survey is not able to establish very detailed pictures of segments of the goods transport market.

National goods transport by Danish trucks

The figures on *domestic haulage* are based on a quarterly questionnaire sampling. Out of the approx. 43.000 licensed lorries (above 6 tons gross weight), a sample of 900 lorries are questioned about the activities during one week.

The publication provides a distribution of the figures (in tonnes and tonne-kilometres) on several categories of commodities at the same level of detail as the NST/R-24 Groups of Goods. This includes four categories of bulk, and general cargo as one category. A breakdown of the tonnes and tonne-kilometres figures is presented on two groups of loading units i.e. containers/swap bodies and “others”. Furthermore, the presentation includes a specification on dangerous goods types and a breakdown into 12 industrial branches.

Based on the sample questionnaires, this statistical publication also presents an OD-matrix of the annual freight transport figures (in tonnes and tonne-kilometres) between all of the 13 Danish counties (which in 2007 were replaced by five regions). Estimated total figures are presented of the number of trips to/from each county, and the total number of trips and million tonnes between East and West Denmark.

International goods transport by Danish trucks

Before 1993, these figures were based on the reporting of foreign trade statistics. As from 1993, the figures presented for *international haulage* are based on a quarterly sample of 700 road haulier companies out of approx. 1600 companies that frequently perform international freight haulage. The sampled companies report on the haulage activities they have started in a specific week or half-week.

For the international haulage a breakdown is provided that presents figures for import, export, cross trade, and cabotage haulage.

As it was the case for the domestic haulage statistics, the presentation of international haulage figures provides a breakdown of the tonnes and tonne-kilometres figures on two groups of loading units i.e. containers/swap bodies and “others”, on several categories of commodities, and a specification on dangerous goods types.

The publication presents a geographical distribution on each country of origin or destination, and a further breakdown of Germany into three regions. These figures are publicised in more aggregated groups, but include a breakdown on 15 European countries, and the total figures for EU countries and "other countries".

Based on similar road haulage statistics from other European countries, it should be possible to obtain some information as well about the quantities of transport by foreign trucks to/from and through Denmark. Eurostat may consider publishing OD-matrices on international freight transport by trucks.

Manual counting of lorry traffic by the Danish Road Directorate
These traffic figures are provided periodically but not always annually. As an example, during 1997-99 there has been no counts of lorry traffic crossing the border between Denmark and Schleswig-Holstein. Manual counts were resumed in year 2000, in co-operation between the Danish Ministry of Transport and the Ministry of Taxation. The counts from 2000 provide a breakdown into three national groups of trucks, i.e. Danish, German and other countries.

Other sources
There is a good possibility to extract computerised and detailed data from the ports and terminals, notably the container and ro-ro terminals in the ports of Aarhus, Esbjerg and Copenhagen, and the railway and combined transport terminals. Such data extracts could provide more specific and precise information about the geographical and modal distribution of freight flows, including transit flows.

As concerns ferry transport, the “Cruise Ferry Info” publication presents aggregated figures for traffic on all international ferry routes, including annual figures of “trailers”. This source is based on the reporting of ferry operators to the national statistical offices. It does not provide any data about the quantities of freight flows, e.g. in tonne-figures, or any other goods transport information in addition to the national statistics. However, the publication offers a useful international compilation covering all countries.

Statistical sources of neighbouring countries
The trade and traffic statistics of Norway, Sweden, Germany and Poland are of particular interest to Denmark. A problem is that the statistical systems vary considerably from country to country. The data are seldom directly comparable, even when it comes to the same international ferry route or cross-border inlet/outlet.

4.4 Transit freight flows

The figure 4.1 above illustrated the trade flows that are embedded in the INTRASTAT and EXTRASTAT statistics.

The national foreign trade statistics does not include any registration of transit trade through a particular EU country, either this transit consists of trade between two other EU countries, or third countries are involved in the transit trade. This shortcoming also applies to Denmark as an important transit country for freight between other Nordic countries and the Continent.

The TRANSITIE pilot study was carried out under the MESUDEMO project and in co-operation with the Dutch Ministry of Transport. The study advises that the problem of the lack of data on intra-EU transit cannot be sufficiently solved in the short term. The TRANSITIE study states that the quality of information about transit through the Netherlands involving third countries has deteriorated during the last few years, especially in the case of transport by sea and rail. “Disguised transit” is transit freight that is customs cleared in the particular country. The opportunity to distinguish this type from real import/export is envisaged to disappear in the longer term.

The TRANSITIE estimate of transit was based on a sample survey, i.e. in 1997 one month of every quarter was processed together, and the observed transport flows were multiplied by the factor 3 to obtain yearly volumes.

Some examples of the difficulties of estimating countries of origin and transit flows were pointed out in the TRANSITIE study. Transit could already have taken place in another country before being imported by sea, e.g. crude oil from Saudi-Arabia is probably transferred in Egypt and oil from Russia is transferred in Latvia. In the case when a commodity from country X is transhipped to a ship in country Y, in the trade database country X will be registered as origin whilst in the transport database country Y will be registered as origin.

In principle, the data about transit flows should be determined as the item that remains from the linking of transport data and national foreign trade data. Such an analysis was carried out in 1990-92 for ferry freight between Northern Jutland and Sweden, when the INTRASTAT had not yet been introduced. A similar analysis has not yet been attempted for ferry freight across the Baltic Sea between Denmark/Sweden and Northern Germany.

Maritime transport statistics and foreign trade data, that are provided to the Eurostat from other EU Member States, might be considered as sources for further analyses on this topic.

4.5 Data constraints and shortcomings

The major constraints to data availability include the increasing commercialisation of data sources, the differences between national statistical systems, the general unavailability or unreliability of data, and different weight definitions.

Commercialisation of data
A constraint is the *increasing commercialisation of transport data sourc*es, and the lack of common requirements and guidelines for data reporting in Europe. This tendency is particularly reflected by the national railway operators, which are in the transition process of being organisationally and commercially separated from the providers of infrastructure services.

As a result, and for commercial reasons, national railway operators have been reluctant to report data except at a high level of aggregation. This also applies to the Danish State Railways (DSB). Some general guidelines should be elaborated at the national and EU levels, in order to ensure access to more detailed information and data than the presently publicised statistics, and without jeopardising commercial confidentiality.

Furthermore, there is no direct public access to the results of the ad hoc OD-surveys that were carried out in connection with the ex-ante analyses of large-scale infrastructure projects in Denmark such as the fixed links across the Great Belt and the Øresund.

Different national statistical systems
A number of data items in the modelling of international transport have to be described based on *statistical systems of different countries*. These systems may

vary considerably from country to country, and hence they produce data with quite different content and preconditions. As an example, international goods transport data in Germany are based on transport statistics, while similar figures in Denmark until 1997 were based on trade statistics, but they do not exist anymore. Since the two ways of measuring are quite different, it is difficult or almost impossible to compare the data of the two systems.

Unavailability of data
The necessary basis for establishing a transport model is detailed knowledge about the actual transport pattern. However, this knowledge is not precise in the sense that *data are either unavailable or uncertain*. The unavailability is also related to the commercialisation of data, see above.

The massive amount of operational information, that is potentially available with the commercial operators, is not available in relation to the strategic models, as the information is often considered confidential. Therefore, it is necessary to base the strategic models on a limited amount of data collection, although they are applied in order to evaluate large-scale investment projects in the magnitude of billions of DKK. It is a question if these models have been sufficiently documented to provide the answers wanted, or if the ability of the models to provide these answers could be improved if access was granted to the operational data.

As an example of the lack of precise data for strategic modelling, the goods transport between Denmark and Germany on the ferry route between Roedby and Puttgarden is not stated in tonnes. However, the number of trucks transferred by the ferries is known with a statistical uncertainty. The numbers vary a great deal depending on the statistical information supplied by Germany and Denmark respectively. No information is available on the origin or destination of the trucks, which therefore should be determined by interviews with the truck drivers. Such surveys could also determine the share of transit traffic.

On the international ferry routes connecting Denmark with Germany and Sweden, a number of unaccompanied trailers are transferred on the direct routes. Therefore, there will be no persons to question about the origin and destination of the trailer. The trailer could contain a number of different consignments to be distributed at different points in Sweden or Germany. However, this information is almost impossible to establish.

Uncertainty regarding the basic data has major consequences for the modelling work. It will be problematic to use sensitivity analysis for these data, since they are the basic data for all estimations and calculations. Therefore, it is important that these data are as representative as possible.

Net weights and gross weights
The Dutch TRANSITIE pilot study has disclosed some significant differences in weight definitions among the various databases. International trade statistics uses net weights whilst transport statistics normally registers gross weights. In some cases the gross weights might even include tare, e.g. the weight of the carrying

container. Such differences have to be neutralised before the harmonisation and integration of databases can take place.

For transit and entrepôt transport, only gross weight figures are available to some extent.

For some types of goods in the EU international trade, weight is no longer recorded. Instead a *measuring unit* (e.g. litres, number of items, pairs etc.) is defined per individual goods type. This problem has to be overcome by estimating some ratios of weight/value or weight/measurement unit by goods type.

5. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarises the recommendations of EU research projects and relates them to the needs to introduce some modifications of the Danish mode-specific statistics.

5.1 Recommendations by EU research projects

The recommendations address the following issues:
- The linking of trade and transport statistics, in order to identify modal distribution and transit flows.
- The harmonisation of data classification including freight flow indicators.

Most of the TRANSITIE pilot study recommendations and findings, aiming at improving Dutch transport statistics, are of some relevance to the Danish situation as well. The aim of the study was to check whether it is possible to get a consistent and reliable picture of the international goods flows from, to and through the Netherlands by other means than the present trade and transport statistics. Among its recommendations are:

- development of a procedure to elaborate transport data on the basis of monthly files on international trade, along with a harmonisation with international trade;
- conversion table to be provided of net to gross weights, on the basis of recent data calibration at a detailed commodity specification level;
- improved procedure to establish transport chains from international trade data on disguised transit;
- analysis of the overlap between entrepôt clearance to the country (the Netherlands) and entrepôt storage as well as clearance to other EU Member States.

The TRANSITIE study points out a need for a methodology linking import/export data and data on entrepôt transport with the transport database. The remaining transport flows should then relate to transit flows. For the determination of transport chains in intra-European transit, a separate methodology will have to be developed that excludes transit in relation to third countries.

Among the suggestions are that the following variables should be considered when linking trade and transport data:
- Mode of transport (sea, rail, road, pipeline, air).
- Direction (incoming/unloading or outgoing/loading in the country in question).
- Country of origin/loading or destination/unloading.
- Country region of origin/loading (probably aggregated at the NUTS 3 county level).
- Commodity group (NST/R-4 digit level).
- Container indicator (yes, no or unknown).

The TRANSITIE pilot study has revealed several procedural differences between the various data sources. Among these differences are the registration of the goods type, definition of the country of origin and destination, the port of registration in the case of a ship visiting several ports, and the degree of containerisation of the goods transported.

However, the pilot study managed to obtain a linking of 81% of both export and import flows with the trade data. This was done by taking into consideration the direction (incoming/unloading or outgoing/loading in the Netherlands), the country of origin/loading or destination/unloading, and the Dutch region of origin/loading or destination/unloading. It was even suggested that a 90% linking could be reached by taking into account some trade flow unbalances concerning the ports of Amsterdam and Rotterdam, oil imports from Saudi-Arabia etc.

A quality check on the transport/trade data is recommended for all countries.

A Danish study, similar to the TRANSITIE case study, should be considered, linking trade and transport statistics in order to identify the geographical distribution pattern including transit flows.

The MESUDEMO project recommends that the following aspects related to goods transport databases should be kept in mind when aggregating the necessary linked transport information:

- A harmonised classification should be used to enable keeping hold of as much detailed information as possible, such as information on the load (consignment).
- Some individual items should be considered as new variables, such as number of trips, number of consignments etc.
- Some additional variables should be calculated, e.g. weight x consignment distance to arrive at tonne-kilometres, capacity x trip distance (loaded or unloaded), etc.
- Consistency should be ensured with the classification used in trade databases for building transport chains.
- Consistency should be ensured with the classification used in other parts of the transport policy information system (socio-economic data, passenger flows, infrastructure links and nodes, impacts).

These aspects are considered in the proposal for goods transport indicators that was presented in Chapter 3.

5.2 Improvement of the mode-specific statistics for Denmark

As for *foreign trade statistics*, it should be ensured that this much more detailed breakdown into commodity groups enables a conversion to the NST-2000 classification eventually to be applied by the Eurostat.

A future *grouping and classification of transport statistics*, with a view to freight transport modelling, could take the point of departure from the INFOSTAT and MESUDEMO project recommendations.

A distinction should be made between bulk and goods organised in loading units, and between low-value, medium-value and high-value goods. This is of particular relevance to the modelling and modal choice.

Modifications of reporting to Statistics Denmark

With a view to improving freight transport information, there is a particular need to modify some of the transport operators' reporting to the Statistics Denmark. This includes a harmonisation of ferry transport reporting and supplementary information about rail transport. Such modifications and improvements are not very comprehensive and costly.

In relation to freight transport modelling, the following suggestions for modifications of the statistical sources would immediately improve the data situation considerably.

Ferry traffic statistics:

All ferry operators should be requested to provide a breakdown on types of trucks and trailers, in compliance with the data breakdown already provided for several national and international routes.

Periodically (e.g. every five years) there would be a need to estimate and calibrate the average loading figures per transport unit based on data samples, and to carry out ad hoc surveys to obtain some basic O/D information.

Port and maritime transport statistics:

The existing statistics is well structured and quite detailed. In general it appears sufficient if combined with other statistical sources. For specific purposes, it is possible to obtain detailed computerised data extracts from the operational databases of the individual ports and terminals. A set of data access criteria and guidelines should be formulated in relation to the aggregation level required, in order to avoid violating the confidentiality of commercial information.

Rail transport:

A supplementary geographically specification is required on goods flows by rail via the few major import/export outlets, and via the Great Belt link and other major sections. This specification could also include throughput figures via the largest combined terminals.

Terminal data extracts and traffic counts:

With a view to obtain more specific information about the spatial flow pattern and other characteristics of freight transport, it should be considered to introduce regular and cost-efficient data extracts from container, ferry and major combined transport terminals.

Automatic traffic counting devices should be installed at major road network nodes and sections, in order to obtain more specific information about the lorry traffic volumes and composition. These counts would need to be supplemented by periodically performed manual counts to obtain more detailed and specific information, and by a few sampled stop-interviews to obtain some basic O/D information.

Major outlets and locations for data catch
Some major locations and outlets for potential freight transport and traffic data catch are indicated on the following overview map. It should be considered using advanced information and communication technology (ICT).

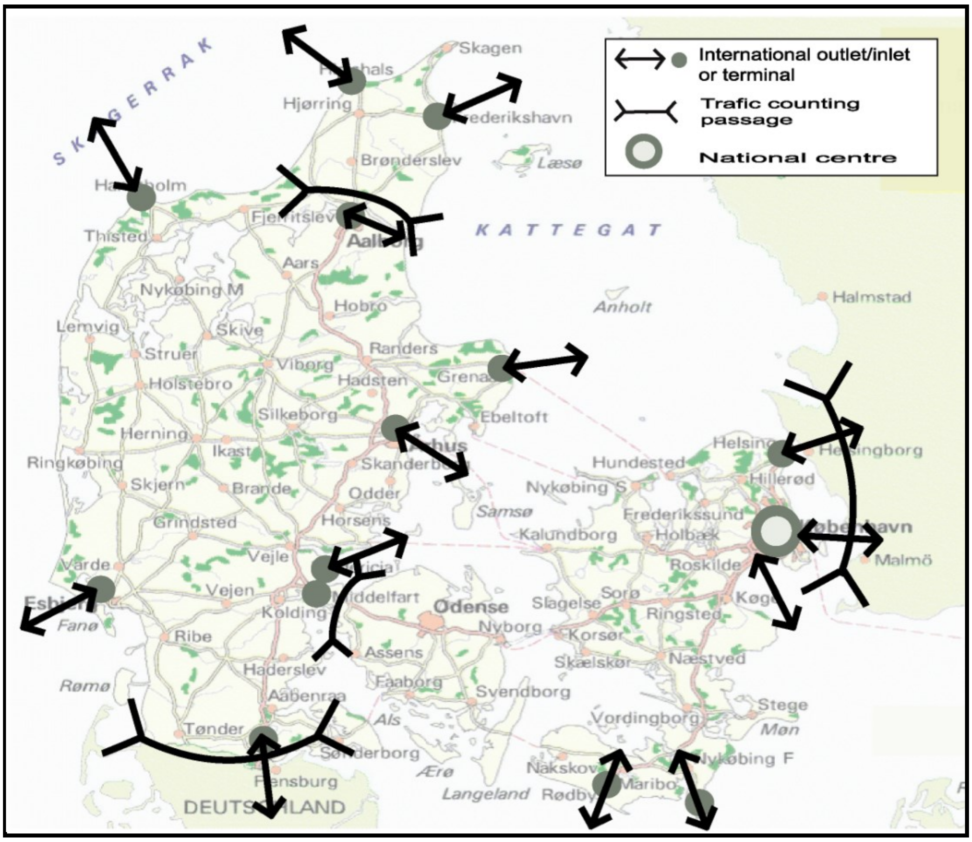

Fig. 5.1: Major terminal locations and outlets for freight transport flows and traffic

A data catchment location should be added to the figure at the Great Belt link.

OD-surveys
The lack of O/D information is still a major drawback in relation to the application of freight transport modelling. Even taking into account that the present statistical reporting of goods transport flows would be considerably improved, the future description of goods transport flow patterns will need, to an increasing extent, to rely on modelling in combination with ad hoc OD-surveys and data sampling analyses.

A national regulation should be issued, to ensure that data obtained from publicly financed OD-surveys are made available to all interested stakeholders. Notably this applies to the surveys carried out in connection with the analysis of large-scale infrastructure projects. Any restrictions should be avoided[2], except for those needed to ensure commercial confidentiality at the company level.

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[2] This "open source" requirement should also apply to databases and modelling tools that are being established under the Danish national transport model.

To facilitate the overall macro modelling, comprehensive national OD-surveys could be carried out at for instance 5 years interval. The models could be used to calculate synthetic OD data for the intermediate years.

A need for Danish pilot studies
A few pilot studies are required in order to obtain the necessary empirical basis for introduction and specification of the modifications suggested above.

A Danish study similar to the Dutch TRANSITIE study would contribute to the development of a methodology for harmonisation of data, identification of modal distribution, and estimation of transit flows.

In order to develop the methodology for estimating regional trade flows, a study could be carried out in order to analyse how to extract the geographical information, that is embedded in the INTRASTAT reporting, in a cost-efficient way. Such a study should consider the experiences gained by the statistical analyses and commodity flow surveys that have been carried out by the Swedish institution SIKA. The surveys are based on individual consignments to/from local units in Sweden.

Interviews and other relevant survey methods should supplement the pilot studies, in order to link the statistical analyses with O/D- and modal distribution information.

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