The Italian Contribution Towards the Implementation of an European Transport Information System: Main Results of the MESUDEMO project

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Sommario

Il progetto MESUDEMO, siglato a settembre 1997 con la Direzione Generale VII della Commissione Europea, ha l'obiettivo di definire la "Metodologia per la costruzione di un database sui trasporti, focalizzato sulla domanda, sull'offerta e sui modelli di supporto alle decisioni di politica dei trasporti". L'ISTAT è uno dei cinque partner che vi aderiscono, oltre alla Agder Research Foundation (Norvegia, coordinatore del consorzio MESUDEMO), il NEA (Olanda) e l'Università Tecnica di Atene (NTUA). In questo contesto ci si è posti l'obiettivo di evidenziare il ruolo strategico del progetto nell'ambito della vasta gamma di iniziative comunitarie in tema di politica dei trasporti, sottolineando il ruolo ricoperto dall'ISTAT e offrendo una sintesi dei risultati finora ottenuti e delle prospettive di sviluppo future. La partecipazione al progetto è in linea con il graduale riorientamento dell'attività dell'ISTAT da esclusivo produttore di dati a creatore e gestore di *sistemi informativi statistici*. Il presente articolo vuole quindi fornire un primo spunto di riflessione verso la messa a punto di una metodologia condivisa dagli Stati Membri e certificata dalla Commissione Europea per la creazione di uno (o più) Sistemi Informativi sui Trasporti. La procedura è descritta nei suoi componenti principali ed è presentato un percorso composto da 16 *steps* per la costruzione del sistema, sia dal punto di vista strutturale (architettura dei dati) sia dal punto di vista dei contenuti (indicatori di domanda e offerta).

Abstract

The MESUDEMO project, signed in September 1997 with the European Commission General Direction VII, has the main aim to define the "Methodology for establishing database on transport supply and demand in Europe". ISTAT is one of the five partners, besides Agder Research Foundation (Norway, co-ordinating MESUDEMO), NEA (The Netherlands) and Technical University of Athens (NTUA). In this particular context it needs to be stressed the strategic role played by MESUDEMO among the wide variety of initiatives and projects concerning transports actually on in Europe, underlying the ISTAT position and offering a landscape of the main results got until now and the future perspectives. The participation to such a project is in line with the new actions that ISTAT is operating since some years, concerning not only production of data but aiming at creating and maintaining alive true *statistical information systems* as well.

This article deals with a first approach towards the fine-tuning of a common methodology agreed by Member States and certificated by the European Commission for the creation of one (or more) Transport Information System. The procedure is described in its main components and it is shown a logical procedure made of 16 steps to get the system creation, both under the structural aspect (data architecture) and content (demand / offer indicator).

1. State of the art[1]

1. 1 Policy challenges

The Common Transport Policy (CTP) is given high priority in the Community. A quick increasing mobility has consequences like bottlenecks on the infrastructure, damaging impacts on the environment and regional imbalances. There is a need for strategic transport research in order to provide the necessary knowledge to support for short term corrective policy actions as well as for long term strategic policy actions aiming at structural changes. Behind this there are numerous aspects linked as well to changes in the way of living in different regions around the Union as to changed patterns of production and consumption of goods. Main problems of the transport sector are:

- economic inefficiencies, including increasing transport costs and the inadequacy of the transport networks to cope with the growing logistic requirements and mobility needs in relation to commercial competitiveness;
- increasing congestion problems in the central parts of Europe and in larger metropolitan areas;
- an intolerable large number of traffic accidents and related high costs to society in general;
- increasing environmental damage and growing energy consumption;
- geographical imbalances and inefficiencies accented by the present transport network structure.

Road transport is dominating. Congestion and externality problems create increasing pressure on policy makers to shift transport to rail and various forms of intermodal transport. Railways have difficulties to respond to increased expectations, not being competitive, neither from the cost side nor in terms of providing competitive quality of service in a modern logistic context relevant for shippers. Infrastructure links across Europe are located in different countries with different policies and regulatory traditions. The main problem is the presence of national monopolies with an inadequate internal organisation and a lack of market oriented behaviour hindering competitive strategies. This is reinforced by the fact that railways have to serve national policy goals where transport development *per se* is sub-ordinate (regional development, etc.). Similar “European” challenges have been pointed at in air transport, where there is claim that there is a potential for a more efficient hub-and-spoke organisation in Europe than the present one, which have been motivated by partly nationally airway companies, with the national capitals as hubs, regardless of other alternatives.

Looking at the policy itself, initiatives are characterised by the dominance of infrastructure concerns. But "hardware" in general is not a scarce factor, and hence constructing new links, tunnels, etc., cannot be the crucial success factor. Large infrastructure improvements will have impact in the long run, and in a way only creates potentials, but they will not by themselves improve the efficiency of the system. The problem of promoting intermodal transport contains many features that are typical for European transport policy. Being a problem of intermodality, the promotion of combining transport modes also requires solutions to problems of interconnectivity and interoperability[2]. The relevant transport distances being long, more than one country is involved. Therefore infrastructure planning (including terminal facilities), regulations of the use of these infrastructures (access, tariffs, quantitative regulations) and subsidies to promote intermodal transport have to be co-ordinated among different countries with different interests. Promoting

[1] This work shows main results got with the MESUDEMO project, carried out by ISTAT and other European partners from September 1997 to September 2000. All the opinions herein expressed don’t involve ISTAT and must be addressed to the authors only, as well as possible errors and mistakes. Roberto Gismondi was the ISTAT responsible for the project, while Massimo Marciani was a consultant. Figures recalled from paragraph 5 on have been printed at the end of the paper.

[2] Generally speaking, we mean the power of a system to be adapted to changes and links with other ones.

intermodal transport in an increasingly competitive and liberalised market also implies considering behaviour on the supply, but above all the demand side. The weight also has to be on promoting efficient use of infrastructure rather than building infrastructure. An important component for the CTP is to create conditions for the interoperability and intermodality of transport networks so as to achieve the most efficient and cost-effective use of the different modes of transport, having regard to their effects on the safety, environment and energy requirements. In the *Transport White Paper* the objectives and scope of the CTP are described, in relation to the principle of sustainable mobility:

"These objectives require the development of policies to ensure that the transport sector can take full advantage of the Treat's provision on the single market and that the different geographical components of the Community benefit from transport systems that will provide services efficiently, safely, under the best possible social conditions and fully respecting the objectives of the Community's environment policy (paragraphs 35-39)".

The main criteria are the ability of the trans-European transport networks to meet the mobility requirements of both citizens and enterprises, and that access to these facilities should be at reasonable cost consistent with their long term maintenance and development. The policy objectives regarding environment indicate that transport systems must contribute to the solution of major environment threats, such as the greenhouse effect, and to the achievement of sustainable development. The objectives of transport efficiency and social cohesion have a spatial dimension as well, in terms of meeting regional development goals and considering the spatial distribution of socio-economic activities, in particular in relation to the development of the trans-European transport networks. Globalisation together with an open and liberalised single market creates challenges of a new kind. The CTP objectives relate to the problems derived from the increasing mobility and the expanded needs for mobility at all geographical levels and in all sectors of the society. Community research concerning transport should provide new tools for realising sustainable mobility: efficient, safe transport under the best possible environmental and social conditions. Internalisation of external costs by pricing or taxation of each mode and system is envisaged to be a major element of the common transport policy. Regarding the principle of *subsidiarity* it is stated that the Community and the Member States have to co-ordinate their research to ensure that national policies and Community policies are mutually consistent. These, and similar, policy problems on the European level call for tools to measure transport performances in a proper way, to link the transport sector to the other sectors of the society, to be able to select the most efficient actions and to calculate - and predict - the consequences. The important process of developing and diffusing a unified European transport policy that appears credible to all European countries, where shape and content of mobility patterns have evolved out of different social and economic histories, also has its imperatives on transport research.

While the European society becomes more economically, socially, and politically integrated, this to an increasing degree underpins the geographical dispersion of activities. Social and economic processes are functionally more integrated than before, but are played out over an extended geographical arena. Local problems do not necessarily have local causes, general solutions to specific problems may create adverse effects in different localities and so forth.

In a project like MESUDEMO, whose aim (in sinergy with several other projects) has been to develop sets of methods that will cater for decision support for European transport policy design, these imperatives have boiled down to two main concerns. *Firstly,* there is a need to harmonise the production of transport information across Europe, in order to achieve a consistent description of transport development. *Secondly,* the production of such information must be designed in a way that promotes an enhanced understanding of the forces that shape and drive transport development. These are both large tasks, and the quantitative and descriptive orientation that was a precondition for MESUDEMO has lead to a prime focus on the first point. The challenge of promoting knowledge about the efficiency of infrastructure utilisation, has led to a project organisation of

MESUDEMO along two lines, where one treats data on infrastructure provision (the supply side), and the other deals with data on transport flows (which then constitutes the demand for infrastructure in this context). The possibility of extracting, storing, and disseminating such information on the European level, through the use of state-of-the-art information technology, is of course, the main achievement of the project.

As we'll see more in depth further, the MESUDEMO project is aimed at defining a MEthodology for establishing a database on transport SUpply, DEmand and MOdelling in Europe. In order to give a comprehensible presentation of such a complex project, it is necessary to structure the outline in a formal and somewhat simplified fashion Knowledge generated in one single sub-projects - called Work Packages (WP) - feeds into the following ones where it is used as the starting point for further research, and so forth, till the final goal is reached by termination of the last WP. As often experienced, however, knowledge does not generate in such a one-dimensional, linear fashion. Just as much, experiences from later work packages "act back" on preceding ones, spurring further work there. This will, in turn, lay foundations for further work in the following WPs, and so forth. This discrepancy between the way knowledge is cumulated and the way the clock is ticking has necessitated deviancies from the original plans of completing deliverables (final official reports to be delivered to the EU Commission), but has not altered the Consortium's determination to finalising MESUDEMO according to schedule. The non-linear, or spiralling form of knowledge generation has presented the project with a series of hen-and-egg problematic whose solutions have not always been inevitable. How does one design transport information for the support of policy decisions when these decisions are based on transport information? How does one, technically, design a transport information system when the content of these databases depend on what is technically viable?

In addition to this, the project has been exposed to several "top-down versus bottom-up" considerations in different situations. Should the construction of European transport information be fitted exclusively to the quest for decision support on the European level, thereby possibly revolutionising both the structures and content of existing transport information systems, or should a future European Transport Information System (ETIS) be built on highly valuable, though fragmented and less compatible, existing systems and data, thereby possibly limiting the scope for decision makers on the European level in designing adequate policies?

In Italy, as well as in European Countries, transport research must respond to policy priorities, but as the political perception of transport also is coloured by deliveries from transport research, this is not just a one-way relationship. A gradually evolving refining of the perception of how the transport system develops hinges on interrelationships between decision makers, planners, researches, and other actors within the system. Therefore, it has been a main concern in the project to establish MESUDEMO as an arena where such mutuality could be reached. MESUDEMO has been a large project, in resources deployed, in time-span, and in thematic scope. Still, it cuts into real life only at a certain stage of development, which underpins the need for continuity in transport research compatible with the continuing and ever-changing character of society itself. It has been argued that all priorities may not be simultaneously achievable, nor do they exist independently of each other. There may also be discrepancies between some kind of scientific ideal and practical research, where beliefs, doubts, trying, and failing is the everyday experience. However, these issues find their solutions through human practice.

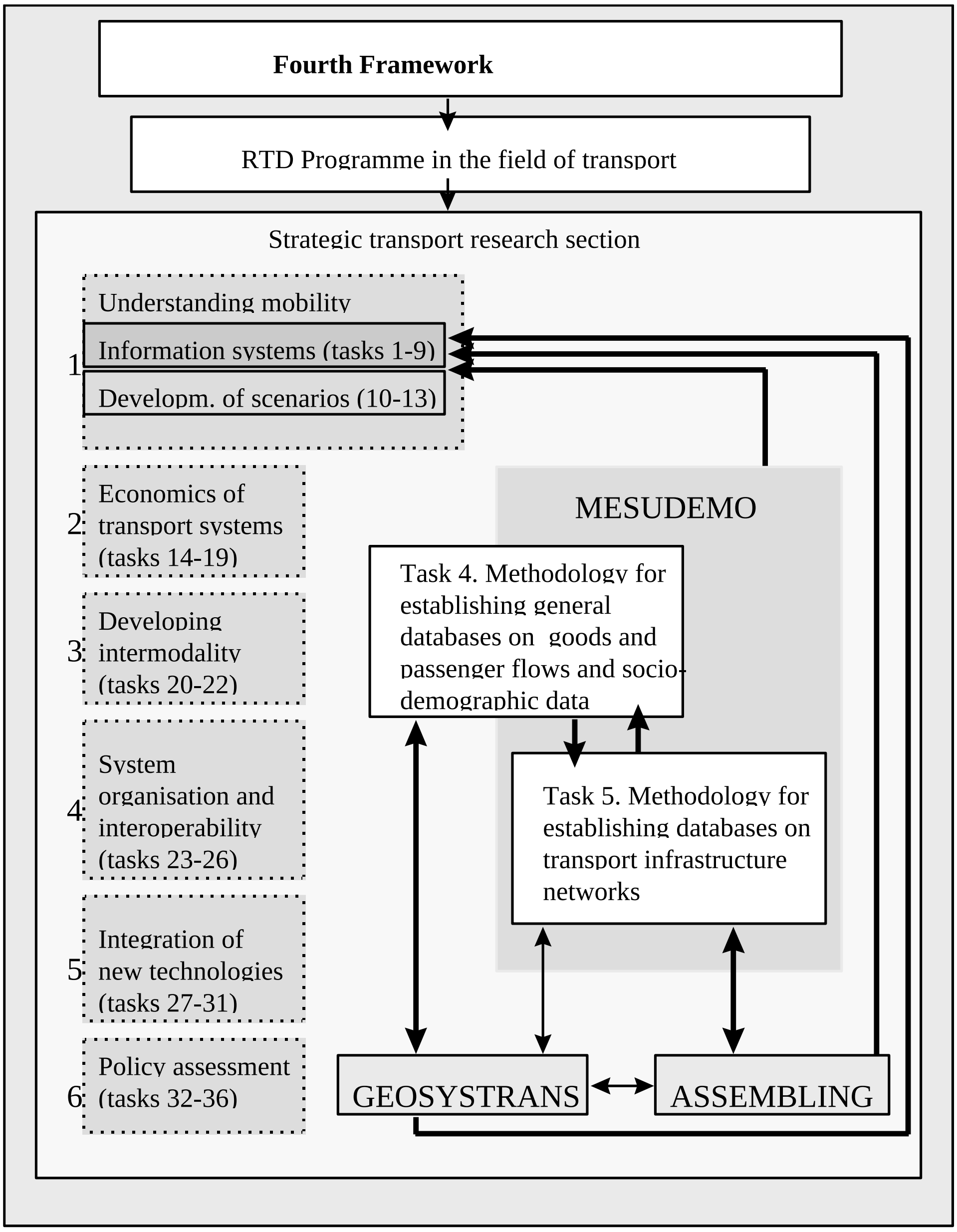
1.2 Decision support system

The effort to narrow the gap between the present situation and the current policy goals calls for decision support system at the European level. This is a question of developing transport planning tools as well as their associated methods and transport data. The concept of decision support contains both the data and the process of extracting relevant information from the transport statistics: available information must be compatible with the questions we want to answer. Each day in Europe governments, business, and consumers make countless decisions about where to go and how to get there, what to ship and which transportation modes to use, and where to locate facilities and make investments. Transportation constantly responds to external forces such as shifting markets, changing demographics, safety concerns, weather conditions, and energy and environmental constraints. Appropriate decisions require having the right information in the right form at the right time. Information on freight activity, passenger travel and vehicle use is basic for understanding the demand for transportation. More careful and cost-effective investment and operating decisions require improved knowledge and understanding of mobility patterns and forces underlining such patterns for both goods and passengers. In order to be able to assess and implement the European policy objectives, there is a need for comprehensive, reliable and timely information system which is presently missing or sometimes not accessible. Of course there is data on transport supply and demand stored in National Institute of Statistics around Europe. A broad variety of traffic and transport data are continuously collected at local, regional and national levels. Apart from these, socio-economic data are also available, providing a large basis for the investigation of transport and traffic demands. Considering the European level, however, the mentioned data sets are not consistent, and the problem became even greater after 1993. Thus the introduction and implementation of the European Single Internal Market from 1993 has brought about positive social and economical effects to all European Union Member States. But, at the same time, and due to the abolishment of customs, we witnessed a rapid decline of transport database availability and as a consequence a deterioration of the quality of existing data. After the disappearance of the European inner borders the quality of import, export and transhipment statistics has deteriorated extensively. In addition, there is a deficit of suitable tools and methods on the international level to process the existing data to information that satisfies the user needs. In particular, methods for the quantification of transport and traffic demands are generally not available at these levels. Although methods for transport and traffic analysis are becoming ever more refined on the national level, these tools are hard to exploit on the European level, because of poor availability of necessary empirical data. This problem exists at two levels: firstly, to an ever-increasing degree like mentioned above, formerly available data is either no longer collected or is difficult to obtain. Secondly, the pan-European focus of the developed policies requires information on a supranational scale. This kind of information does not adequately exist at the present. Efforts are currently made in Europe to change and reverse this deplorable trend.

1.3 Transport research background

The vision of ETIS, a European Transport policy and planning Information System, is recognising the above mentioned challenges and poor decision support tools to face them, and this is a core aim in the Strategic Section of the Transport Research Programme. This programme is within the 4th Framework of the EU. MESUDEMO is placed within the first of six fields of investigation in the research programme. This first field “Understanding mobility”, was again subdivided into “Information systems” (Tasks 1-9) and “Development of scenarios” (Tasks 10-13, see figure 1-1). Proceeding MESUDEMO, the three tasks of the First Call, also called immediate actions, provided the basic framework of a European information system, with its concepts and definitions, an evaluation of existing information, and an identification of the most urgent gaps to be eliminated. The definition and standardisation of European wide available and consistent data sets were one of the outcomes of the research projects covering the first three tasks. This knowledge and the outcome of other relevant published and ongoing studies served as a basis for investigating methodologies for the establishment of databases on transport flows, socio-demographic data and transport infrastructure.

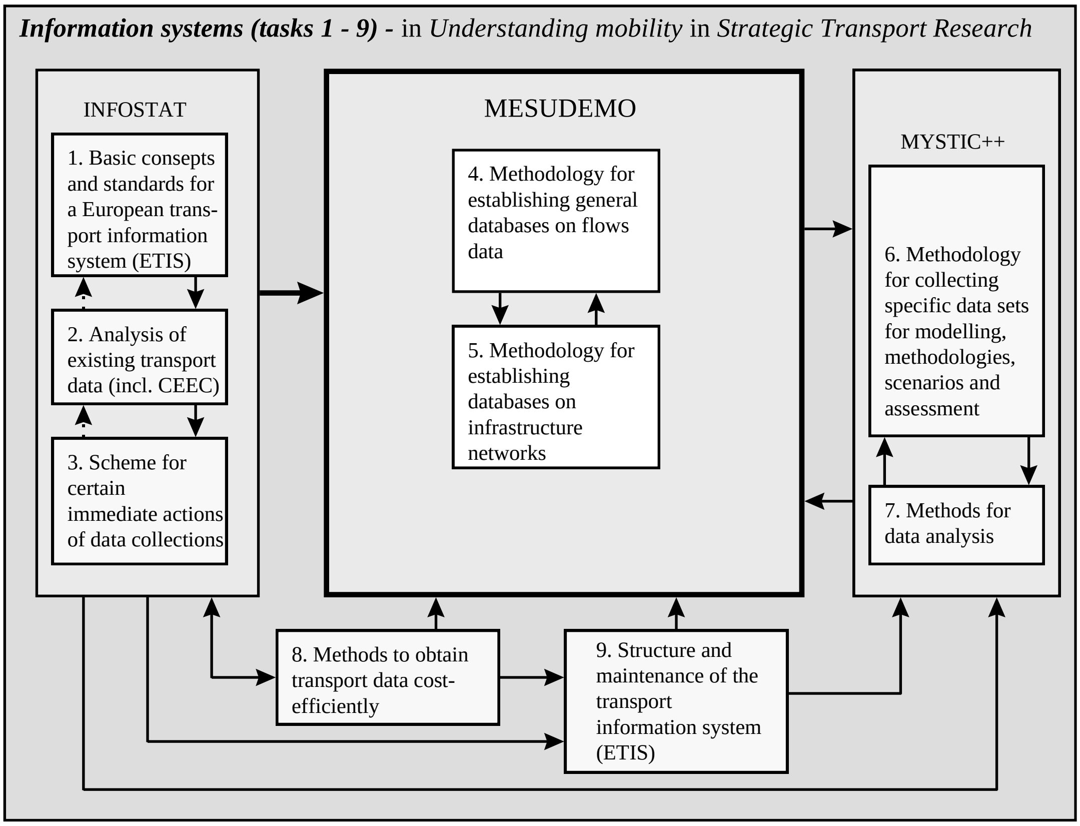
Figure 1-1 MESUDEMO within the Fourth Framework Programme



The work tasks 4 and 5, see figure 1-1 above, were the natural and logical complementary activities and steps required for successful establishment and implementation of the ETIS. The MESUDEMO study including part of task 4 and the whole of task 5, is intended to co-operate with two closely related projects such Mystic, Dateline, Most, Geosystans and

Assembling[3]. MESUDEMO though, would not evolve in isolation from the line of thinking that resulted in the division of labour between projects as well as the interrelations between them. MESUDEMO was to bring the process of creating ETIS one step further, and it was therefore of great importance that MESUDEMO continued to build on the work done in previous or ongoing projects in the research programme. The following figure places MESUDEMO among the Information Systems tasks:

Figure 1-2 MESUDEMO within Information Systems



The MESUDEMO project is aiming at the implementation of a European Transport policy and planning Information System (ETIS) which will be an instrument that will **assist and support decision-making of the European Commission**. The importance of such a system was strongly underpinned by both DGVII, now DGTREN and by EUROSTAT. Furthermore MESUDEMO benefits of the outcomes form CONCERTO, transport research accompanying action devoted to the results elicitation and consensus building process within Member States.

2. Methodology adopted and baseline results

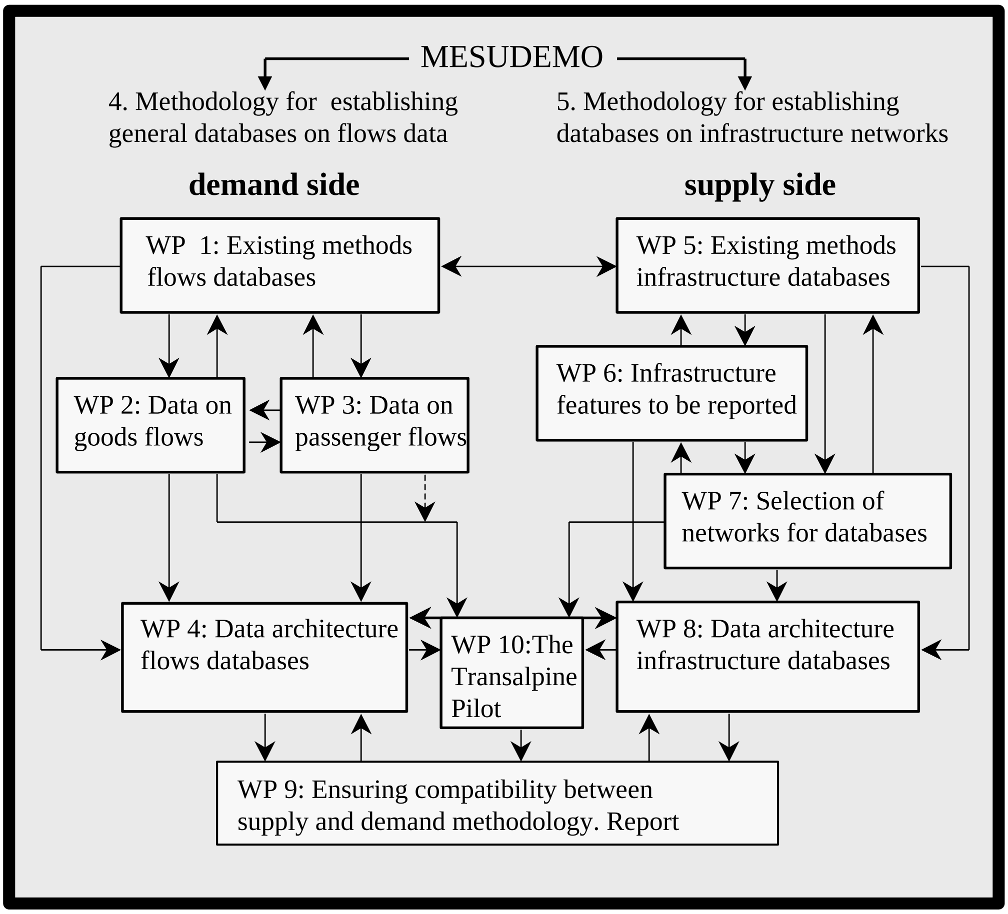
In order both to identify gaps, to recommend methods for constituting ETIS and for the purpose of securing commitment and feasibility of the solutions, the methods carried out in

[3] More information can be found in http://www.cordis.lu/transport/src/project.htm

MESUDEMO ranges from the very broad general to the narrow and specific one. From the questionnaire survey giving the general impression on the pilot studies focusing on limited issues in restricted areas, the method chosen for the MESUDEMO project can be described in a three-step approach:

1. Make an analysis of the relevance of and significant discrepancies between existing procedures used to produce current databases, or to estimate variables and select appropriate methods.
2. Describe and develop a final method fitting with the basic concepts of Task 1, and draw up the presentation framework.
3. Test the method for constituting and presenting the database by using existing and/or model data.

Figure 1-3 The Workpackages and organisation of MESUDEMO



In addition to distributing work between the partners, the project was divided into ten different Work packages, interlining each other as in the figure below. The division and the timing is in accordance with the three step approach.

Starting off the project were WPs 1 and 5, step 1 above, with a questionnaire survey and in-depth interviews mapping the state-of-art in Europe when it comes to transport databases and information systems. Immediately following were WPs 2 and 3, step 2, developing suggestions towards variables on flows that were essential as the basis for supporting policy decisions, now and in the future.

The WPs also were to supply a procedure of estimation of those variables which were urgently needed, but missing at the time. Then, the network to include in the system was developed in WPs 6 and 7, still step 2, both for modelling and for decisions regarding infrastructure. Finally WPs 4 and 8 suggested an integrated architecture for the system that revealed itself through WPs 1-3 and 5-7, where WP9 secured compatibility between the supply and demand data and tools. The Transalpine pilot, WP10, along with pilots in WPs 2 and 3, were both laboratories for the findings in MESUDEMO, but also a first step on the road towards implementing ETIS (step 3).

2.1 Basic research orientation

Questionnaire survey

There was in the MESUDEMO project a need to take one further step into reality, trying to "get behind" the information gathered in INFOSTAT. The original main purpose of a questionnaire survey was twofold:

1. Since MESUDEMO was going to come up with methodologies for a complete information system, it was regarded essential to have good descriptions on alternative ways of organising transport information systems around Europe. We thus wanted to identify some good practices to learn from in the process of describing the architecture of the pan-European system. This called for a comprehensive survey of each database, getting insights into every step and functionality in the production process of the database. Since at the outset the research team did not have the knowledge of the distribution of good practices in Europe, the challenge was to try to get a large number of answers to a large number of questions. This initial approach had the clear disadvantage that a low response rate was achieved, since filling in the questionnaire would be a time consuming burden on several persons in each institution.
2. The second purpose of the questionnaire survey had as its departure point the fact that many of the respondents represented possible parts of the architecture of ETIS, in the form of sources of information. Therefore it was regarded as interesting to compare and assess the possibilities of linking the respondents together in an integrated information system in the future.

Sample

The sample was decided to be as wide as possible in order to create a first linkage among MESUDEMO and related key actors and, of course, to reach all possible database holders. It resulted in a sample of 99 respondents across Europe. Some relevant respondents were found among the institutions involved in EC projects' dissemination activity. Also, the list of database holders from the UN/ECMT/ EUROSTAT common questionnaire was used as a basis for finding good databases.

Design

The design of the questionnaire was, due to reasons mentioned above, comprehensive and detailed both on technical issues, methodology for gathering information, organisation and dissemination, and also contents. The questionnaire was over 50 pages long. The partners provided very detailed questions on both infrastructure and flows, specified for each mode, so that questionnaires would have been tailored-made to each respondent. Through a pilot survey, it was clear that this approach was too optimistic. The questionnaire was narrowed down to seventeen multiple choice questions, divided into three parts, i.e. database coverage, technical aspects and database use. Much of the work with the first questionnaire was used later in the in-depth interviews; it functioned as a learning process that would bring results later on in the project. The reason for this was to reduce the response burden, to try to get as many answers as possible, and also the fact that the most relevant database holders would, in any case, have to be contacted later on for in-depth conversations.

Performing the survey

All the Members made contacts with the institutions according to their geographical responsibilities. Some institutions were impossible to get in contact with (11), and thus no questionnaire was sent to them. Some respondents answered that they did not keep a transport database (9). Some received a questionnaire, but did not answer (28). The rest (51) returned the questionnaires filled in. The questionnaire contributed in several ways to the project:

1. It was a useful process to obtain inputs from all WPs so that questions relevant for all the Work Packages were included, thus the construction of the questionnaire represented a starting point for the work on all Work Packages.
2. The results from the survey constituted a basis for WPs 1 and 5, describing existing methods for transport information systems in Europe.
3. The general impression from the responses was a necessary departure point for selecting interview objects for in-depth interviews later on in the process and for establishing contacts with transport database holders.
4. An assessment of the databases in Europe, which provide MESUDEMO with inputs about possible solutions for a Pan-European database on infrastructures and flows. The questionnaire was to give inputs both to how an information system for transport can be designed, that ETIS can learn from smaller systems, but also how the smaller systems can be integrated into one bigger system; the ETIS.
5. The broad distribution in itself established attention towards ETIS among experts in the European countries.

2.2 In-depth interviews

The drawback of a quantitative questionnaire survey, as a method, is the lack of contextualised information. In order for MESUDEMO to provide a vision of the whole information system, we needed experiences on the complete production process of the database. The respondents' different preferences on the ”modules” in the system (surveys, harmonisation, software, hardware, dissemination media etc.) probably are better explained by the context they belong to, in time and space (Flyvbjerg, 1993, 57), than the isolated characteristics of the selected solutions. It would thus be a big mistake if we did not go into deep on selected cases, but just selected the most frequent used solutions to the ”modules” needed in ETIS. The advantages of in-depth interviews are that they are more able to get a grasp on the functionality and organisation of a complete system. In addition, one can, through the course of the interview, detect aspects not contemplated before the investigation. A drawback is that interviews of this type are rather resource demanding. The aim of the interviews has been twofold: firstly, to get a better idea of the state of the art when it comes to collecting, storing, maintaining and disseminating transport information. This will be an important part of the input necessary for the other Work Packages that seek both to come up with a methodology for the creation of ETIS and to make a small-scale exercise of what the ETIS might look like in practice. Second, the goal has been to establish a network of data providers in Europe and to market the idea of ETIS to these data providers. The success of ETIS relies heavily upon co-operation with data providers and their attitude towards the idea of establishing and maintaining a European Transport Information System. The Questionnaire survey and inputs from other partners and experts within the field of transport were the main basis for the selection of institutions interviewed in depth. Some international databases pointed themselves out looking through the answers to the Questionnaire, but also national databases covering many modes, intermodal transport and both flows and infrastructure looked promising for the future process of designing ETIS. The selected institutions include national statistical offices, transport ministries and other public institutions, supranational institutions and commercial companies. A comprehensive interview guide was produced, covering both technical questions and questions about sources and content and database use. In most institutions we talked to several persons, since our scope was broader than the field of expertise of single actors. The interviews were open, since at that point in time we did not have the precise enough vision of ETIS and what was relevant and adequate information. On a total we performed 13 interviews in 5 countries. Out of these were three international organisations (Eurostat, ECMT and UIC), two statistical offices (Italy and Norway), three Ministries of Transport (Holland, Italy and France), one port (Rotterdam), one railway company (Italian) one air operator (Italy) and two motorway companies/organisations (Italy and France).

2.3 Workshops

The workshops (seminars organised during the project in order to discuss main results achieved) were essential for co-ordinating aspects of possibility of data collection and data need and user requirements. The invitations to the workshops went out to all relevant database holders and all relevant research projects. *Horizontally*, the workshops were an instrument for scientifically progress *within* each on-going Work Package, as well as a first introduction of the coming WPs. *Vertically*, the workshop functioned as an instrument for disseminating acquired knowledge *between* each WP, as well as between the MESUDEMO project and related projects and institutions. The first workshop was arranged in Copenhagen on May 11^{th} and 12^{th} 1998. Eurostat participated on almost every MESUDEMO meeting, and we were invited to discussions on the rail directive in Eurostat later on. The UN/ECE participant gave us good insights into the common questionnaire, what is already known about transport databases in Europe and many new contact addresses for the in-depth interviews. The second Workshop took place in Rotterdam on the 17^{th} and 18^{th} of June 1999. Especially pleasant here was the presence of several representatives of the Commission, giving us inputs towards the needs for ETIS and the role of MESUDEMO in this context. We also learned much from external experts, both in other 4^{th} Framework projects, and people with viewpoints from outside European transport research.

2.4 Pilot studies

The pilots in MESUDEMO served at least three purposes, or one purpose on three levels:

1. Firstly, we needed laboratories to test out hypothesis developed in the project. The real-world examples that we needed were hard to access and probably even not existing. Also there are few or none examples of organising information geared towards pan-European policy issues, existing systems are national or uni-modal. Thus we had to create our own ”cases”, based on our rising knowledge on how to design a pan-European system.
2. Second, the questionnaires and the in-depth interviews did not give good enough examples on the feasibility of the ever clearer vision of the architecture of ETIS. It is needed to check results from desk research and meetings, against limited problems and geographical areas in Europe. It was always an aim that MESUDEMO were going to recommend methodology for

establishing ETIS, and the pilots were used to check to which degree the results were feasible and sustainable in the European transport environment.

3. Thirdly, there were discussions during the project, on whether a huge standardised integrated pan-European system was needed and thus, would it be maintained if the costs overwhelmingly exceeded the apparent usefulness? One argument against such a system was that each policy question and each area called for specialised datasets, unique harmonisation procedures and tailored-made models that all had to be geared towards that policy question and which in consequence could not be readily available in ETIS. The pilots would give us knowledge about what could be done with *existing* data and models, and thus if it was worthwhile spending resources on making a pan-European system based on existing data and tools. These pilots were in line with an explorative method. Hopefully though, the research team could get closer to the knowledge in the pilots. After all, trade data is available in all countries and in similar formats. Household surveys, roadside interviews, surveys on own account and road-counts are available for most areas, so methods for making use of such data does have generalised interest.

It was agreed that it was a necessary part of MESUDEMO to actually test the method for constituting and presenting the architecture of ETIS by carrying out a suitable pilot, demonstrating the possibility of combining flows and infrastructure data. The idea of the Transalpine Pilot focusing on transit transport in the Alps was considered as a good example of policy issue with a strong European interest, and proper to be used in a pilot for testing the feasibility of a system consisting of elements of an ETIS. The Transalpine Pilot was aiming at examining in practice and in detail the way to use transport knowledge and existing datasource and models to see if it is possible to answer some simple policy issues. The aim is to construct a system with many of the same characteristics as ETIS. The Pilot was connected to a complex transport area with a highly political dimension which directly involved four EU countries and one non-EU country (Germany, France, Italy, Austria, Switzerland), and indirectly other countries of transit like the Netherlands and Belgium. There was a high degree of Community interest in relation with the negotiations between the EU and Switzerland regulating Alpine transit, and the Common transport policy dealing with intermodality and trying to promote sustainable environmental friendly transport solutions. A huge volume of freight was crossing the Alps, raising questions about mode choice, the use of existing infrastructure, environmental impacts etc. Several studies had been undertaken corresponding to different interests, policies and data problems.

The main objectives of the Transalpine Pilot were to investigate how far towards ETIS one could reach by using all available data and information to

- to demonstrate the *need* of an information system, which implicates:
- to show the limits of current systems of information;
- to determine which gaps had to be filled (both on information and information systems);
- to show that technical solutions exists for combining different types and sets of data and information. The interface towards the users were crucial here;
- to take into account the articulation between the various research projects on Information systems, within the 4th Framework and the articulation between European research and national research projects.
- to demonstrate the effect for *building up* a comprehensive information system, which implicated:

to exemplify the top-down approach: Policy issues → conceptual approach → indicators → variables → existing/to be completed data.

to exemplify the bottom-up approach by indicating which and how data from dispersed sources could be collected and combined in order to come to a consistent information system. Here the architecture of the system and the interface towards the sources of data were the crucial items to deal with.

3. Current practises

At this point, a crucial issue has to be emphasised:

In the course of the MESUDEMO, the situation in Europe and the State-of-Art in the Information Technology and the Telecommunications has been changing at an extremely fast rate.

This fact introduced a considerable difficulty in the work of the project since the working team had to check and, when necessary, update its work-plan and actual work each time new State-of-Art information was available and/or evolving transport databases and corresponding decision support system became available for examination. The commercial GIS tools, which are available at this moment, are far superior and considerably more flexible that those that existed at the starting point of MESUDEMO. In fact, *they have advanced so much, that they allow (and dictate) a different, much more advanced architecture of the Data Core of ETIS* (such as the proposed in this deliverable). *New databases for Transport Information and Decision Support Systems are emerging in Europe*, such as the system of the Italian Ministry of Transport, which is a fully developed Decision Support System, implementing the full Italian National Transport Model. The Database Management Systems (DBMS) have enriched their ability of "data modelling" (i.e. internally representing the information), turning towards the object-relational organisation schemes, thus greatly enhancing their abilities of handling in technically sound ways complex and diverse data. Moreover, most of the advanced DBMSs of today provide the possibility of creating *open and scalable systems* (i.e. systems which can grow on demand in a very graceful manner, as far as the implemented applications and the system configuration and processing power are concerned). Advanced programming environments, *Web-enabled and with a very high degree of portability across hardware platforms*, have emerged and become commercially available (such as the Java language, running on the Java platform). In fact, major suppliers of DBMSs have implemented the latest versions of their software systems in such environments, in order to achieve compatibility across different hardware platforms. More and more commercial tools for the creation of *Data Warehouses and Knowledge Bases* are becoming available. The evolution of the *Federated Database Systems* (FDBS) have established an alternative to the integration of distinct DBMSs: a FDBS supports the loose co-operation of distinct, autonomous, heterogeneous DBMSs, so that global applications accessing these DBMSs can be created and operated in a way transparent to the users. *Virtual databases* can be created in this manner.

The Geographical Information Systems (GIS) have considerably advanced, providing the flexibility of open, object-relational data models (internal data representations) and a very high degree of co-operation with advanced commercial DBMSs. In fact, the providers of such advanced GIS already propose the organisation of large geo-databases in DBMS environments, and limit the operations of the GIS to very advanced visualisation and spatial analysis capabilities. On the other hand, some advanced DBMSs do have the capability of internally representing and analysing spatial data. Most software products, including the DBMSs and GISs, are now Web-enabled; i.e. they permit their users to connect to them remotely through the World Wide Web (WWW), while maintaining all or most of the capabilities that the local users have. As far as the Transport Databases are concerned, there is a considerable multiplicity of them in Europe; *however, there has been so significant effort for a basic harmonisation of their content or for their co-operation*. The description of these Databases is beyond the scope of this document.

Types of Existing Transport Databases analysed in MESUDEMO research are:

- Local (regional) databases, such as the following: Alpine regions, Adriatic corridor, Pyrenees crossing and others.
- National databases, mainly created and maintained by Statistical Offices, Infrastructure Administration Offices, Ministries of transport, Local Administrations, Private companies.
- International (supra-national) Databases, created and maintained by: EUROSTAT, International Organisations such as the UIC, the International Road Federation, ECMT, IATA, International efforts and studies, such as the RADEF database, the CAFT database, etc.

4. European Transport Information System architecture

The aim of the Information System (IS) of the Statistical Offices are to organise and provide statistical information on Transport and not to standardise datasets. The internal organisation of the data is not so demanding: the main need is the handling of very large matrices, possibly of more than two dimensions. This is also the case of the EUROSTAT transport databases. On the other hand, EUROSTAT has already developed the GISCO database, which includes a GIS-based infrastructure network database[4]. There is a fundamental difficulty when trying to build an ETIS system. In creating and using a national system, a top-down approach can be used:

> *Policy issues - Formulation of the questions, to which the IS has to provide answers - Decisions on what kind of data and algorithms have to be included in the system - Collection of the necessary data and construction of the system - Building of the IS and answering the policy options*

In an ETIS, however, the situation is different. In most cases data are already available through agreements with the Member States. These data, however, are not necessarily most relevant ones, or in the same form or format as National data. Some examples will help in understanding the nature of the problem:

In collecting data for the long-distance passenger trips in Europe (Mystic project), the following difficulties were highlighted:

i. The very *definition* of long-distance varies across countries. In some of them 100 km had been selected (e.g. Sweden), in some other 80 km (i.e. Germany). Passenger samples by age group varies as well. Furthermore in most countries passenger trips only included trips by nationals while actual transport volumes would make most sense when travels by both nationals and foreigners were calculated. In the European

[4] This network database is currently being updated and enriched by APUR, a French company, on behalf of the Commission and EUROSTAT. Both the older version, and a part of the one under update have been given to the MESUDEMO project, in order to be used in the work and research of the project.

perspective the harmonisation of much nationally collected data is called for and is for se a formidable task.

ii. The resolution of representing the regions of origin and destination was quite different in the case of international trips. For example, in the German and French data sets, the German regions of origin are very detailed (much more detailed than NUTS 3), while the regions of destination in other Countries are very coarse (often at a NUTS 0 level). In the effort to create an O-D matrix for passenger trips from France to Germany and vice versa at a NUTS 2 level, joining regions of origin to a NUTS 2 level poses no problem; however, breaking down the destination regions and the corresponding data in NUTS 2 regions, actually involves an difficult estimation procedure, with no guarantee for the resulting data quality.

iii. The data sets received from the Member States were in different forms: simple survey results by some countries, O-D matrices by others and data were old and of different years. Therefore, the harmonisation procedure includes an effort for bringing these data sets at the same time, same form and format (provided that problems like these described in (1) and (2) have been solved in an acceptable manner).

iv. There is a sensible reluctances of National Bodies to co-finance ETIS initiatives and further developments because of subsidiarity.

So, in the case of ETIS, the top-down approach has to be combined with a bottom-up one:

1. *Policy issues - Formulation of the questions, to which the IS has to provide answers - Initial decisions on the kind of* ***desired data and algorithms*** *that have to be included in the system*
2. *Determination and harmonisation of the* ***available*** *data or the* ***data that can be collected***
3. *Determination of the* ***possible algorithms and processing methods*** *that can be successfully used*
4. *Identification of the* ***questions*** *to which the resulting information system can answer.*

Then, and only at that stage, the ETIS system can be set up. It must be stressed that it might be necessary that the aforementioned procedure be repeated iteratively, even more than once, in order to reach a plausible data arrangement in order to work on the corresponding problems. In the work for the Transalpine Pilot, it has been realised that:

a) There is a considerable abundance of data, concerning the pressing problem of the freight traffic in the Alpine Crossings. A number of related databases, which have been used in the Transalpine pilot, are summarised below as an indication of the diversity of sources that may appear in any problem of this kind:

Supranational databases

CAFT	1994 – survey transport data (Cross Alpine Freight Transport)
TRAINS	1995 – transport data (EUROSTAT)
TREX	1995 – trade data (EUROSTAT)
NEAC	1995 – transport chain data (property of NEA)

Transhipment data

SLA Hamburg	1995 – trade / transport data
Bremen	1995 – trade / transport data
Belgium	1996 - trade data
Netherlands	1995 - trade data

National databases

France	1995, transport/trade data
Austria	1995 from 1993 – 1994, not yet available, transport
Switzerland	1995, transport data

Clearly, these databases include widely different data and data descriptions, and, naturally, different internal structures. Selecting the proper data from these databases, importing the corresponding data sets, and validating and merging the selected data, in order to create a consistent data set for a specific reason (such as the study of the Transalpine traffic problem and its possible solutions), is by no means a trivial job. A specific effort, in which transport experience is heavily involved, is absolutely necessary for this purpose.

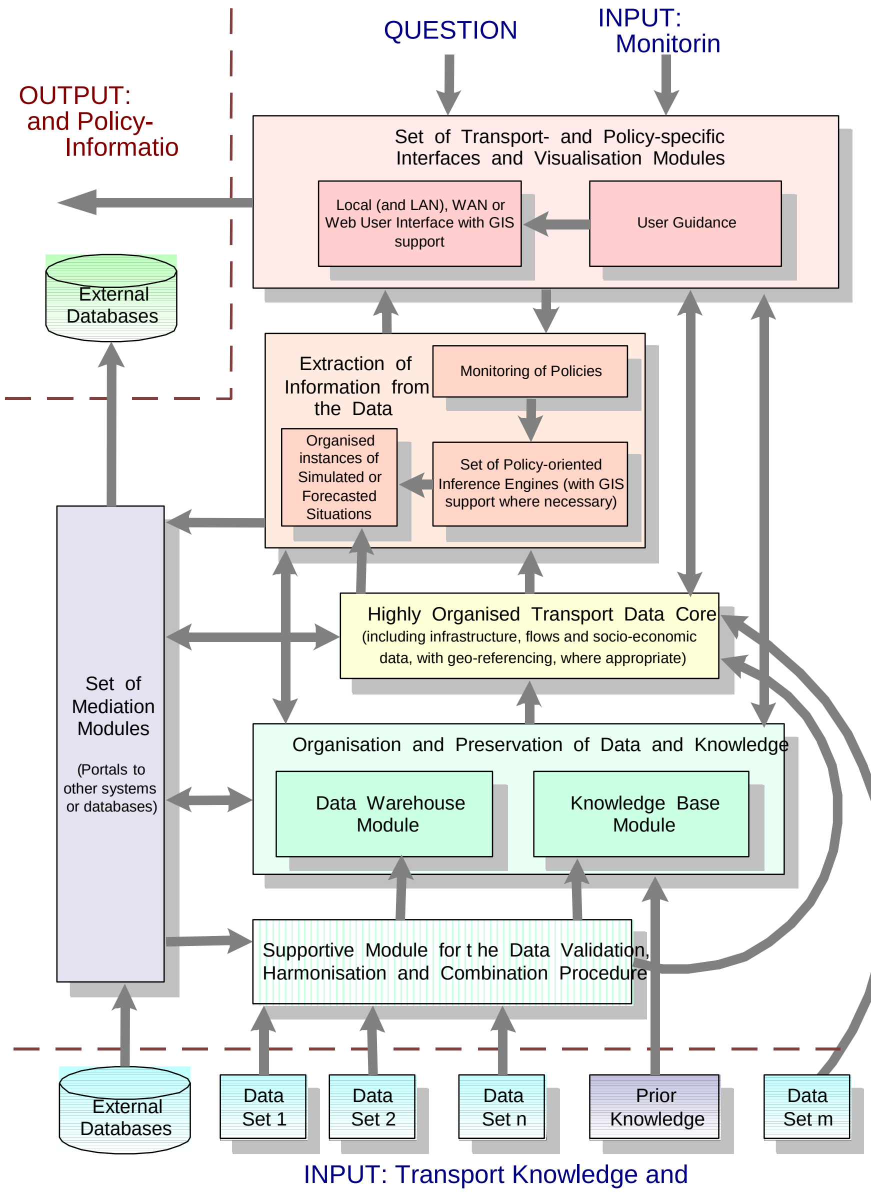
b) However, in some relevant cases, it is quite possible that the already available data are not enough for giving a final answer on the corresponding problems and creating an ETIS. In such a case, the use of more fundamental data acquisition methods required, before any attempt towards an ETIS.

The main objective has been the development of a set of data models and the corresponding data architecture for the creation of a European database on transport flows and transport infrastructure.

The main results can be summarised as follows:

- A better understanding of the organisational and technical nature of ETIS has been achieved as to aim and form, technical needs and solutions, installation and maintenance etc.
- A step-wise practical path to a future ETIS has been envisaged and described.
- A concrete need for preparatory work at the European level has been identified.
- A general architecture of an ETIS-type system has been developed, and the main modules of it have been further analysed.
- A novel internal data architecture and the corresponding data model for the transport infrastructure networks and the transport flows have been developed, which:
    - For the first time, takes into account critical parameters such as the level-of-detail, the relevance of the associated information (e.g. the network and region attributes, etc.) to the transport or policy issues at hand, the possible locality of the problem at hand (e.g. the local problems of specific corridors) etc.
    - Can support widely different needs, ranging from organising transport supply and demand information to transport modelling and forecasting. It can also resolve problems from the diversity of the transport data.
    - Permits the seamless integration of external, third-party data sets and processing methods (including models), without violating ownership and confidentiality issues..
    - Follows the current state of art for creating open and scalable systems.
- An implementation methodology for ETIS which reduces the installation and maintenance costs and permits the open (but controlled) access to its data and processing methods, has been developed. This methodology, moreover, permits the easy construction of third-party additional software for ETIS.

The following figure outlines the general architecture of ETIS, showing the various sub-systems at a conceptual level.



A general architecture of ETIS, showing the various sub-systems at a conceptual level

5. A pilot application of ETIS architecture in the Transalpine area

5.1 Introduction

The main objective of the study is to demonstrate the need and to test the feasibility of building up an ETIS to be applied to a chosen specific area that raises sensitive political issues and where one might expect that the necessary data could be compiled and brought together. The choice fell on ETIS applied to the Alps. Therefore the database has been called the Alpine Transport Policy Information System (ATIS). In the pilot study the database should contain detailed information on land born vehicle and goods movements for all relevant Alpine crossings, but the study should also implement a transport chain concept and provide information on short sea shipping. No existing data source alone can provides this information. By combining different sources a real added value could be achieved. The activities follow the structure of the path for constituting ETIS:

1. Define the relevant policy issues
2. Define the corresponding indicators
3. Build up a methodology for computing the policy-relevant indicators from the data
4. Build an actual test database using real data
5. Calibrate and apply the method to estimate the effect of chosen policies
6. Suggest architecture and methodology for generalisation of the ATIS case.

Alpine policy issues are an essential input for the identification of indicators and variables necessary for ATIS. The availability of specific indicators for the region has been analysed from two perspectives: observed and estimated data. The efficiency of ETIS applied to the Alps has been assessed through the interaction of the top-down approach with the bottom-up approach. To understand the selection of the indicators and variables, the policy issues that have been identified as being of particular relevance to the Alpine region, are listed below:

1. Promoting combined transport
2. Improving competitiveness of railway companies
3. Optimal route selection in the Alpine region (avoiding detoured traffic, justified sharing of burdens of Alpine countries)
4. Assessing political measurements and specific regulations (Swiss agreement, Ecopoint system)
5. Impacts of toll systems and user fees on route choice in road transport
6. Ecological and social impacts of Alpine traffic considering the specific situation of the mountainous landscape
7. Assessing the impacts of infrastructure closures (tunnel closures, blockades)
8. Assessing the impacts of new transport infrastructures
9. Promoting alternatives to Trans Alpine transport (short sea shipping).

It has to be kept in mind that the variables and indicators proposed for ATIS are concentrating on the more transport related policy questions, which is only one part of the Alpine transport policy dimension. Other parts such as the specific ecological and social situation in the Alps, although being very important have not been treated in the context of MESUDEMO. The chosen issues that the Transalpine Pilot Study can deal with, are the following ones:

A. The pattern of Alpine road traffic

- Flow distribution over Brenner

- Flow distribution over Mont Blanc
- Flow distribution over Gotthard
- Pattern of flows from The Netherlands to Italy
- Pattern of flows from Rotterdam to Milano.

B. The impact of events and policies on Alpine road traffic flows

- Impact of events
- Assessment of route changes when closing Brenner
- Assessment of route changes when closing Mont Blanc
- Impact of restrictive policies on road transport
- Assessment of Swiss road toll on road - rail modal split
- Assessment of Swiss road toll on the pattern of road traffic crossing the Alps.

Considering the whole range of policy questions identified for the Alpine area and the possible estimates of the Transalpine Pilot Study, the following correlation can be made between the policy questions and the possible estimates:

Alpine policy questions	Transalpine Pilot Study estimates
Promoting combined transport	Assessment of Swiss road toll (four levels) on road - rail modal split – partial
Improving competitiveness of railway companies	- *not implemented, but it can be done*
Optimal route selection in the Alpine region (avoiding detoured traffic, justified sharing of burdens of Alpine countries)	- *not implemented, but it can be done*
Assessing political measures and specific regulations (Swiss agreement, Ecopoint system)	- *not implemented, but it can be done*
Impacts of toll systems and user fees on route choice in road transport	Assessment of Swiss road toll on the pattern of road traffic crossing the Alps: *four toll levels*
Ecological and social impacts of Alpine traffic considering the specific situation on the mountainous landscape	- *additional instruments have to be implemented*
Assessing the impacts of infrastructure closures (tunnel closures, blockades)	Assessment of route changes when closing Brenner Assessment of route changes when closing Mont Blanc
Assessing the impacts of new transport infrastructure	- *not implemented, but it can be done*
Promoting alternatives to Trans Alpine transport (short sea shipping)	Flow distribution over Brenner Flow distribution over Mont Blanc Flow distribution over Gotthard Pattern of flows from The Netherlands to Italy Pattern of flows from Rotterdam to Milano

The actual Transalpine Pilot Study shown Figure 5.1 could answer to a large range of the policy questions. Some estimates listed above were not computed due to time and resource constraints. The current approach is based on the following criteria:

1. Make use of existing data to the maximum extent
2. Make use of existing Pan-European transport models to the maximum extent
3. Apply a large-scale information system to estimate the local impact of policies: traffic changes on Alpine crossings.

ATIS includes three main parts:

Input data, which in the current application are classified in:

1. Data on transport demand, which should be organised in such a way as found in the latest *state-of-the-art* in European research and exemplified in projects INFOSTAT, MYSTIC and MESUDEMO.
2. Data on transport supply, represented by the modal and/or intermodal networks. In the present case the application has been limited to the road network, for which the GISCO road network has been made available by EUROSTAT
3. Cost information, which consist of road cost function which is approximated using information from STEMM project.

Existing models, systems and theories as:

1. modal split module of the NEAC transport policy information system
2. multiple route assignment technique.

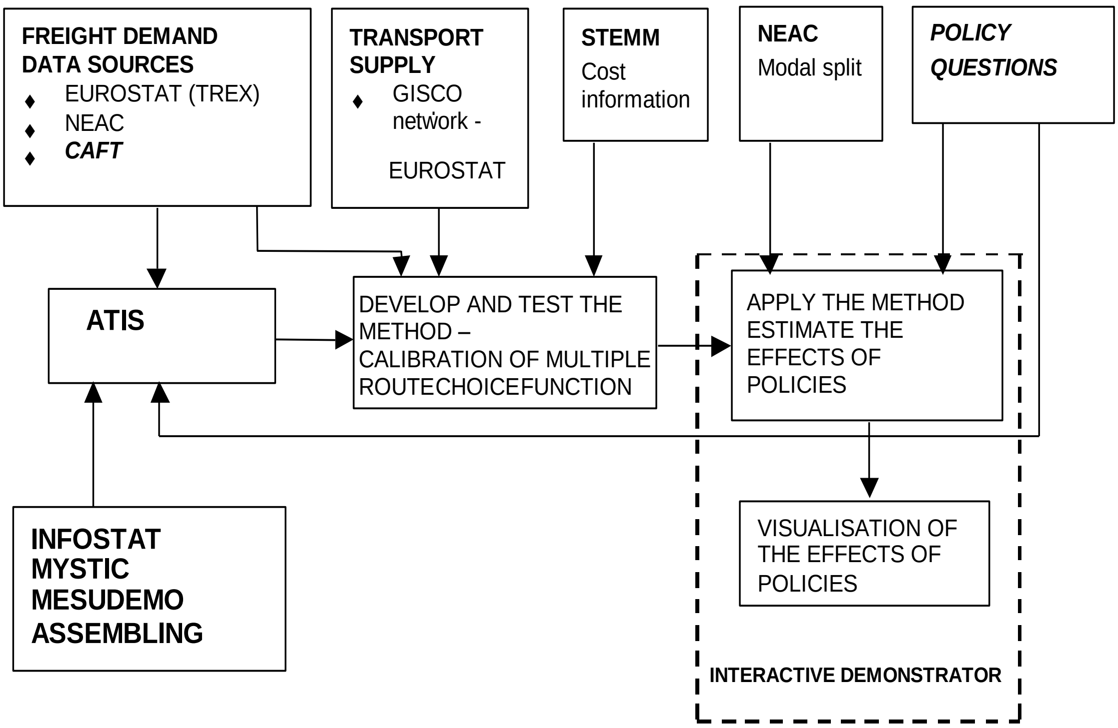
Software and interface tools, as:

1. The DELPHI software tool, which includes a multiple route assignment module and manages the interactive demonstrator
2. MAPX, which is the GIS visualisation tool.

The *interactive demonstrator* has been built in the Transalpine Pilot Study to demonstrate the possibility of enabling the policy makers to visualise the effects of the applications of different policy options. This interactive demonstrator is able to:

1. Show the pattern and structure of existing flows
2. Estimate the effect of infrastructure closures on the pattern of road traffic flows
3. Estimate the impact of different road tolls in Switzerland on the pattern of road traffic flows.

Figure 5.1: ***Transalpine Pilot Study in ETIS context***



The interactive demonstrator could be extended in the future in such a way as to be able to extend the range of interactive answer to other policy issues.

5.2 Development of the Alpine freight transport demand database

ATIS freight demand database has to use different sources. The evaluation of these sources and recommendations of the INFOSTAT and the MESUDEMO project imply that the most relevant indicator for goods transport demand is:

No.	Label	Unit of measurement	Observational unit	Priority level for ETIS
1.	Total annual interzonal goods transport flow by commodity group, mode (or combination of modes) and type of transport chain and by *Alpine crossing*	Tonnes/ year	O/D pair	Fundamental

The new dimension that is considered in the Transalpine Pilot Study is the Alpine crossing, which enable the desegregation of interzonal goods flows by commodity group, mode and type of transport chain over the Alpine crossings. The following sources were used to collect the data to be combined in order to derive the ATIS database:

ATIS: supranational

CAFT 1994 - survey transport data

NEAC 1995 - transport chain data

TRAINS 1995 - transport data

TREX 1995 - trade data.

ATIS: national databases

France 1995, transport/trade

Austria1995, 1993 - 1994 not yet available, transport

Switzerland 1995, transport

Germany 1995, road 1995 from 1992, transport

Belgium 1996, trade

The Netherlands 1995, trade

UK 1995 from 1991 (MDS), trade

Spain 1995 from 1992, trade.

ATIS: transhipment data

SLA Hamburg 1995 – trade / transport

Bremen 1995 – trade / transport

Belgium 1996 - trade

Netherlands 1995 - trade.

Based on the experience achieved and on the suggestions of working groups, the guidelines to be followed in the data harmonisation procedure were designed to be simple, robust and understandable and give reliable results. In order to achieve this goal, the following steps were followed:

STEP 1: Collection and harmonisation of data for comparison

STEP 2: Implementing chain organisation and regionalisation of trade flows at NUTS 2 level by the use of NEAC95 database

STEP 3: Adjustment towards Alpine transport chain organisation

STEP 4: Distribution of transport chain along Alpine crossings

Due to the very different approaches of obtaining the data at the TREX and the Transalpine database, it would not be surprising if significant differences were observed. Bearing in mind the possible bias of enterprise based data collection and customs declaration on the one hand and a sample of lorry driver interview on the other hand, the rather homogeneous picture shown seems almost surprising. The remaining differences can to a large degree be explained by methodological reasons. Trade flows between Switzerland and Italy or between Austria and Italy do not necessarily cross the Alps, which might explain that the CAFT database shows a lower figure in these cases than TREX. CAFT has registered in total 132 million tonnes. Italian international transport flows have the highest share, representing **72.40** per cent of the total. Domestic transport in Austria and Switzerland account for **14.80** per cent of the total and non-Italian international transport accounts for the remainder **12.80** per cent of the total transport volume. The specific Alpine transport chain organisation and Alpine route related information for a trade volume of ***77 million tonnes*** is included in ATIS database from the total of ***132 million tonnes*** that are registered by the Transalpine database. This is so because only Italian imports/exports in relation with the most important partners have been considered. ATIS freight transport demand database includes finally the freight flows at the regional level desegregated per origin, destination, transport mode, transhipment location, commodity group and Alpine crossing.

5.3 Alpine transport supply data for the demonstrator

The Alpine transport supply considered for the pilot study consists of the road network that covers the whole Europe. The GISCO road network was made available by EUROSTAT (GISCO is the Geographic Information System of the European Commission). Typical road attributes are the length of each segment, the road number (national and European), and the type of road segment. Speed is a very important item not found among the attributes. Knowledge of speed is very important for building the path for each O/D pair. Another important component which is not found among the attributes either is AADT (Annual Average Daily traffic) expressed in PCU's (Passenger Car Units) and/or distributed between cars and trucks. As the value of average operating speed for freight transport is essential for the Transalpine Pilot Study, speed was estimated using another variable found in the GISCO network, the road segment. Cost of road transport is expressed as a function of distance and time and is the basic element in determining the optimum route between origin and destination. It is further used as input for the route choice function. As for assignment, the goods flows have been considered at an aggregated level. It was necessary to find that cost function which makes the average over different types of goods and truck loading. The source for approximation of the cost function is the STEMM project, which makes a review of the VOT (value of time) and fixed costs (per tonne-km). On the basis of the findings in the STEMM project the following cost function is approximated (costs in Euro/tonne):

$$\text{ROAD COSTS} = 0.0458 * \text{DISTANCE} + 0.079 * \text{TIME}$$

This cost function is further used in the calculation of the generalised transport cost for each O/D pair and for each possible crossing over the Alps. The total volume of goods that is transported by road between an origin and a destination region is distributed over the Alpine crossings by a multiple route choice function which is calibrated further. This cost function is used as an average and only for road transport. Future developments of multimodal route choice procedures will have to consider a possible diversity of the cost functions reflecting the differences in transport chain structure (discontinuity of route, type of good, diversity of modes, etc.).

5.4 Development and calibration of the multiple route choice function for assignment

The actual pattern of Italian road traffic flows on Alpine crossings is revealed by the distribution for Italian import and export flows over the crossings. Summarising the flows included in the ATIS database, the distribution of selected Italian imports and exports by road over the Alpine crossings is derived. The results are shown in table 5.1 below where the Alpine crossings are described as follows for all the following tables.

Table 5-1: Foreign trade of Italy, observed flows (million tonnes) for road transport

Type of flow	Alpine crossing														Total
	P_23	P_21	P_22	P_11	P_12	P_13	P_15	P_31	P_32	P_33	P_34	P_35	P_36	P_37	
Import	3,01	6,38	8,97	0,21	0,02	1,96	0,15	0,18	9,13	0,14	1,55	0,10	0,71	0,23	32,75
Export	2,84	4,47	6,33	0,57	0,15	4,44	0,27	0,26	7,23	0,13	0,49	0,09	0,24	0,70	28,20
Both dir.	5,84	10,84	15,30	0,79	0,17	6,40	0,42	0,44	16,37	0,27	2,04	0,19	0,95	0,93	60,95

P_11 = Gr. St. Bernhard Suisse
P_12 = Simplon "
P_13 = Gotthard "
P_15 = San Bernardino "
P_21 = Mt. Cenis France
P_22 = Mt. Blanc "
P_23 = Ventimille "
P_31 = Reschen Austria
P_32 = Brenner "
P_33 = Felbertauern "
P_34 = Tauern "
P_35 = Schoberpass "

P_36 = Semmering Austria
P_37 = Wechsel "

The region-to-region road flows on the Alpine crossings at the level of commodities, are further used as observed data in the process of calibration of the multiple route choice function. As the flow from one origin to one destination is distributed over more crossings, the all-or-nothing technique can not be used as an assignment procedure in this exercise. The solution was to calibrate a so-called multiple route choice function, which will enable the simulation of the distribution of flows over Alpine crossings. The logit function was chosen to be the algorithm and calibrated. The calibration consisted in estimating the parameters of the multiple route choice function considering as constraints the (observed) flows over each Alpine crossing, per direction.

5.5 Assessing the existing pattern of Alpine road traffic flows

The structure of selected Italian road freight flows crossing the Brenner, Mont Blanc and Gotthard is given in Table 5.2 below.

Table 5-2: Italian import and export flows by road over Brenner, Mont Blanc and Gotthard – ATIS database. Million tonnes

Country (partner)	**France**	**BLEU**	**Netherlands**	**Germany**	**Denmark**	**Portugal**	**Spain**	**Norway**	**Switzerland**	**Austria**	**Total**
Road flows over Brenner											
Imports	0.11	0.35	0.34	7.41	0.22	0.00	0.00	0.00	0.00	0.70	9.13
Exports	0.00	0.20	0.17	6.43	0.14	0.00	0.00	0.10	0.01	0.19	7.23
Total	0.11	0.55	0.51	13.84	0.36	0.00	0.00	0.10	0.01	0.88	16.37
Road flows over Mont Blanc											
Imports	4.05	1.71	1.68	1.46	0.04	0.00	0.00	0.00	0.03	0.00	8.97
Exports	3.19	0.87	0.74	1.37	0.04	0.00	0.00	0.03	0.09	0.00	6.33
Total	7.24	2.57	2.42	2.84	0.08	0.00	0.00	0.03	0.12	0.00	15.30
Road flows over Gotthard											
Imports	0.06	0.13	0.12	1.05	0.02	0.00	0.00	0.00	0.59	0.00	1.97
Exports	0.18	0.16	0.13	1.41	0.02	0.00	0.00	0.02	2.52	0.00	4.44
Total	0.24	0.28	0.25	2.46	0.04	0.00	0.00	0.02	3.11	0.00	6.41

The structure of road flows crossing a corridor helps in identifying those flows which could be affected by a change (a restriction) in road transport on that corridor, and by identifying the relations for which an alternative route (i.e. including short sea or inland waterways) could be further analysed. The structure of selected Italian road freight flows crossing the Brenner, Mont Blanc and Gotthard is illustrated in the figures 5.2 - 5.4 in the Annex 10.3.

Figure 5.2: ***Structure of road freight flows crossing the Brenner***

Figure 5.3: ***Structure of road freight flows crossing the Mont Blanc***

Figure 5.4: ***Structure of road freight flows crossing the Gotthard***

The pattern of Italian road freight flows from The Netherlands to Italy, and from Rotterdam to Milano at NUTS 2 regions, is illustrated in the figures 5.5 and 5.6 in the Annex 10.3 from this picture the distribution of flows over the Alpine crossings could be depicted.

Figure 5.5: ***Pattern of road freight flows from The Netherlands to Italy, by region***

Figure 5.6: ***Pattern of road freight flows from Rotterdam to Milano regions***

A first observation on the pattern of flows from The Netherlands to Italy is that the most used route is the one over the Mont Blanc crossing, with more than 0.9 million tonnes per year. Regarding the transport flows from Rotterdam to Milano (NUTS 2) the most used route is also the Mont Blanc crossing.

5.6 The impacts of events and policies on Alpine road traffic flows

Infrastructure closures are considered as events and they are simulated within the Alpine transport system by closing the specific links. The events that were considered were the two main Alpine crossings: Brenner and Mont Blanc. Once the infrastructure closure is implemented in the road network, new road flows are produced assigning the O/D matrix to the network. Road flows that previously took place on the crossing that has been closed, are redistributed over the other crossings. The effect of closing the Brenner is quantified by the differences in the road traffic flows on each link in the network, as illustrated in figure 5.7 (see Annex).

Figure 5.7: ***Change on road freight traffic flows when closing Brenner***

The changes in road traffic flows shown above consider both imports and exports of Italy from the selected EU countries. Next, the changes of the distribution of Italian import and export road traffic flows on each Alpine crossing are estimated. The results are shown in table 5.3 below.

The highest changes in road traffic flows are observed over the Swiss crossing San Bernardino: flows increase 8.37 times for imports and 5.69 times for exports, with the contribution of 13 per cent for import and 14 per cent for exports from initial Brenner flows. Also over the Austrian crossing Reschen the road flows increase 6.45 times for imports and 4.54 times for exports, with the contribution of 9 per cent for imports and 10 per cent for exports from initial Brenner flows. The differences are relative, as they relate also to the initial flows on the crossings that are affected by the closure of Brenner. As example, Gotthard takes over 22 per cent for imports and 27 per cent for exports of initial Brenner flows, while Tauern takes over 23 per cent for imports and 20 per cent for exports. The effect of closing the Mont Blanc is illustrated in figure 5.8.

Table 5-3: Impact of closing Brenner on the distribution of Italian import and export flows by road over the Alpine crossings[1] (new flows/original flows)

Type of flow	Alpine crossing														Total
	P_23	P_21	P_22	P_11	P_12	P_13	P_15	P_31	P_32	P_33	P_34	P_35	P_36	P_37	
Import	1.02	1.08	1.23	1.04	1.06	2.11	8.37	6.45	0.00	1.44	2.16	1.16	1.22	1.50	0.99
Export	1.00	1.07	1.25	1.03	1.00	1.46	5.69	4.54	0.00	1.31	3.76	1.22	1.15	1.10	1.00
Both dir.	1.01	1.07	1.24	1.03	1.01	1.66	6.87	5.37	0.00	1.43	2.51	1.18	1.15	1.19	0.99

[1]The Alpine crossings are described as in table 5.1.

Figure 5.8: ***Change on road freight traffic flows when closing Mont Blanc***

The changes in road traffic flows shown above consider both imports and exports of Italy from the selected EU countries. The changes of the distribution of Italian import and export road traffic flows on each Alpine crossing have been estimated and the results are shown in table 5.4 below.

Table 5-4: Impact of closing Mont Blanc on the distribution of Italian import and export flows by road over the Alpine crossings (new flows/original flows*)*

Type of flow	Alpine crossing														Total
	P_23	P_21	P_22	P_11	P_12	P_13	P_15	P_31	P_32	P_33	P_34	P_35	P_36	P_37	
Import	1.14	1.87	0.00	1.18	1.42	1.48	1.18	1.07	1.18	1.00	1.01	1.06	1.00	1.00	1.00
Export	1.06	1.83	0.00	1.17	1.14	1.25	1.09	1.10	1.15	1.00	1.10	1.00	1.00	1.00	1.00
Both dir.	1.10	1.85	0.00	1.18	1.17	1.32	1.13	1.08	1.17	1.00	1.03	1.04	1.00	1.00	1.00

The Alpine crossings are described as in table 5.1.

Majority of the total traffic diverted from Mont-Blanc tunnel (61%) goes through the Fréjus tunnel crossing, compared with the 84 per cent resulting from the 1999 French transalpine survey during which the Mont-Blanc catastrophe occurred[5]. The highest changes in road traffic flows are consequently observed over this French crossing (increase 1.87 times for imports and 1.83 times for

[5] Reference situation of 1999 Mont-Blanc traffic without closure estimated by: January 1999 to March 1999 traffic x July 1992 to June 1993 traffic / January 1993 to March 1993 traffic.

exports –1.85 as a whole in 1999 according to the French transalpine survey[6]) and over the Swiss crossing Gotthard (increase 1.48 times for imports and 1.25 times for exports). The increase in the road traffic flows over the crossings does not consider the capacity restraints on those links. As an example of the impacts of restrictive policies on road transport, an assessment of Swiss road toll on road/rail modal split has been carried out. To have a better image of the effect of the level of road toll in Switzerland on the road/rail modal split, four road toll levels were considered:

Level 1: Road toll for crossing Switzerland is 2.00 EURO per tonne;

Level 2: Road toll for crossing Switzerland is 5.00 EURO per tonne;

Level 3: Road toll for crossing Switzerland is 10.00 EURO per tonne;

Level 4: Road toll for crossing Switzerland is 15.00 EURO per tonne.

The NEAC modal split model is used to estimate the new modal split between road and rail. The input to the NEAC model consists of the new difference between the road and rail generalised cost. As toll is applied to the road transport, there are no cost changes for rail transport. NEAC modal split model is applied four times, once for each road toll level. The output of the modal split model is shown below.

EFFECT OF SWISS ROAD TOLL ON MODAL SPLIT

Road toll in EURO/tonne	Modal shift road	Modal shift rail
2	0.976	1.099
5	0.940	1.240
10	0.886	1.460
15	0.832	1.680

As the rail flow volumes are lower than the road flow volumes the relative change is higher for rail than for road transport. After the modal split has been applied, new road flows have been estimated in the O/D matrix of direct road transport for each level of toll. Further, a new assignment takes place and the difference between the new and previous (original) loaded network has been calculated. The impact of Swiss road tolls of 2, 5, 10 and 15 EURO per tonne is shown in figures 5.9-5.12.

Figure 5.9: ***Swiss road toll of 2 EURO per tonne***

Figure 5.10: ***Swiss road toll of 5 EURO per tonne***

Figure 5.11: ***Swiss road toll of 10 EURO per tonne***

Figure 5.12: ***Swiss road toll of 15 EURO per tonne***

In the case of gradual road toll increase in Switzerland it is observed a tendency of gradual increase of the traffic flows on the French and Austrian Alpine crossings, and also on segments of road

[6] Reference situation of 1999 Frejus traffic without Mont-Blanc closure estimated by: January 1999 to March 1999 traffic x July 1992 to June 1993 traffic / January 1993 to March 1993 traffic.

situated outside the Alpine area. The increase in road traffic flows over the crossings does not consider the capacity restraints on those links.

6. A feasible path to ETIS

The success of the ambitious effort of creating, or, more accurately, *deploying* ETIS (and the ETIS Network) for Europe, absolutely depends on a correct understanding both of the way that such a deployment has to be done, and of the fact that a series of preparatory actions on behalf of the Commission are absolutely necessary.

These actions fall in the following categories:

- *Awareness of the social and transport problems, for which ETIS is definitely needed*:
  - There must be a very careful, comparative evaluation of the hot transport problems or policy issues in areas around Europe, for which a localised TIS or a DSS is a need with a high priority. The creation of a localised system for these areas has a meaning, only is it can be used in a sustained manner (and therefore, it is regularly updated).
  - Moreover, there must be an comparative evaluation of the needs for installing a Pan-European system for making possible the study of European-wide problems and support the decision making process, either directly through the use of a DSS, or indirectly, by providing information, which can help in better understanding the problems and the implications of the corresponding policy and transport options.

The reason for this essential action is *to clearly set the priorities for taking the first steps towards the deployment of ETIS*. It may be necessary to create a European Steering Committee for deciding on these first steps.

A) *Preparation for the creation of European-wide databases for Transport. A better understanding of the data needs, the methods for the initial data acquisition and the regular data updates, as well as the form that an ETIS would take is absolutely essential*, in order to take the correct steps for the deployment of ETIS. The results of the Transalpine Pilot should be carefully studied in all their dimensions and the resulting implications on the methodology that has to be followed, in order to go on, should be deeply understood.

B) Moreover, the Commission stimulated by Member States should initiate certain preparatory actions at the EU level concerning organisational and technical matters. These actions include:
   - Promotion of an action for the *creation of a Data Dictionary* at the European level for a *Basic Common Data Set of Transport Information*. This Data Dictionary should be complete with an internal description of the corresponding data, not merely a glossary, so that it could be directly used for the organisation of the Data Core of ETIS. *It is very important to understand that this Data Dictionary can only be Issue-relevant*, i.e., that the kind and form of its data directly and absolutely depend on the transport and policy problems that have to be faced. Therefore, the creation of this Data Dictionary should be considered as a *dynamic procedure*: the start should be done for a typical set of transport and policy issues, and updated and expanded in the future in a controlled and technically sound way. This update and expansion should be guided by a careful examination of the

corresponding State-of-Art and the evolution of the data needs, which is perceived as the deployment and exploitation of ETIS continues.

- *Provision of a proper nomenclature and coding schemes for essential Transport information*. (e.g., an action for the creation of a Unique Identification Scheme for the Infrastructure elements, which does not depend on geo-referencing). *This action should be carried out in co-operation with the Member States*.

It is also understandable that in the evaluation of the overall situation, as well as in carrying out the first steps towards ETIS, other important preparatory steps may come up. It is the opinion of the research group that the overall responsibility for getting the whole effort towards the ETIS deployment started, as well as the decision on the first steps towards this aim, should probably be taken by the primary users of the system, namely DG TREN. However, since these matters are of a highly political nature, it would be advisable to refer to the authority of the European Parliament for validating, or even directing these actions.

6.1 Sixteen steps for the creation of an ETIS

Suppose that a decision has been taken for the creation of an ETIS (i.e., a system of the ETIS Network). The following procedure can be followed for the systematic analysis of the data, the processing methods (including the models), the architecture and the interfaces of the system:

Step 1.

List the most pressing transport or policy problems, for which solutions should be provided by this system. Include typical questions, for which an answer would be preferably provided by this ETIS.

Step 2.

Convert these problems or questions to *transport or policy options (or measures)*, which have to be examined as possible ways of solving the problems or answering the questions.

Step 3.

List the set of the indicators, which are *necessary for evaluating these options or the implications of these measures*.

Step 4.

Determine the *methodologies*, which are needed for the computation of these indicators. Determine, therefore, exactly which data and computation methods (including models) are needed. Determine, also, the desired Level-of-Detail and geographical coverage of the data.

Step 5.

Complement the lists with data and computing methodologies (including the models) that are not indicated by the procedure so far, but which, according to the educated “feeling” of the Transport experts, may be proven useful in the future, as far as the understanding of the transport problems in the area are concerned.

Step 6.

Then, *go shopping for data*. I.e., contact all those data providers, who may have the needed data. Prefer, if possible, those providers, who are responsible for the production and update of the primary sets (e.g. the Member States for the Transport networks). Determine, therefore the availability of the needed data, the way to establish the paths for acquiring and regularly updating of the data, if there are any confidentiality issues, regarding these data. In such as case, look for an arrangement for sorting out this matter (it may be necessary to programme this arrangement in the system).

Step 7.

If the data exist, then determine what kind of possible *harmonisation*, *validation* and/or *merging* is needed, and go to step 8. If however, *there are significant gaps in the data*, or *the data would not be disclosed*, then look for alternative sources; examine if these sources can provide data at the desired quality and regularity. If proper sources are found, then go to step 8. In the case that there are still severe data gaps, *examine if there may be found alternative ways of getting the needed data*, such as possible reliable estimation of the missing information, or possible collection of primary data, etc. If such alternative, *applicable* ways can be found, go again to step 8. Otherwise, examine if desirable results can be produced with the (not complete) data set that may be acquired, and if it is still worthwhile to create this ETIS at this moment. If yes, then *adjust (i.e. reduce) the set of transport problems or policy issues that can be answered*, *execute again steps 2, 3, 4 and 5* and then go to step 8. If not, *drop the job for the time being* (there is always a chance that the missing data will be available in the future through collection of primary data or otherwise).

Step 8.

Having determined the questions, to which the system can provide answers, given the data availability, *technically design the system at the conceptual level*, following a top-down approach. The process described in the previous steps would have already formed the *Issue-relevance Table*. Use this Table for organising the data of the system. Try to follow as much as possible the overall architecture previously presented therefore making final decisions on important issues like the following:

- Which of the data sets have to be included in the Data Warehouse, and which of them will be eventually fed to the Highly Organised Data Core? The Data Core will be used both for organising Transport data (the function of a TIS), and for providing necessary data for the computation of the policy-oriented indicators (as part of a DSS).
- What procedures and tools may be needed in validating, harmonising and, possibly, combining the data sets?
- Which are the external, organised databases, from which data have to be taken, or to which data have to be delivered?. Moreover, determine if any mediation is needed between these databases and the ETIS system under design.
- The structure of the modules of the overall architecture: The supportive module for the data validation, harmonisation and merging, the Data Warehouse and the Knowledge Base, the Highly Organised Data Core (HODC), the module for the Extraction of the policy-oriented Information (which should include any models or other methods of producing the needed indicators), and the corresponding User Interfaces. For each one of the modules, determine also the needs for input and output data.

Moreover, try to follow the design principles already described for achieving a flexible and effective system.

Step 9.

Decide on the software platform, the development environment (see glossary) *and the software tools,* which have to be used (such as the DBMS, the GIS, possibly some commercially available transport models, etc.). Use a platform, a development environment and software tools, which guarantee an open and scalable architecture, and encourage the construction of third-party software. Use an advanced Database Management System (not a GIS), with proven stability and performance, as the heart of the Data Core organisation.

Step 10.

Based on the decisions for the software platform, the development environment and the software tools, *as well as on adequate samples of the data*, *conclude the design* (logical and physical) *and the construction first of the basic data-centric modules* (see glossary), *and then of the rest of the modules of the overall architecture*.

Step 11.

Based on the decisions taken in steps 6 and 7, *acquire the data*. Some of them should be already available from a permanent, centralised acquisition activity; e.g. the Infrastructure Networks, which have to be taken from the Member States and updated regularly. Other data would probably be acquired for the first time, in order to be used by the ETIS system under design. Finally, parts of the data may come from similar systems, i.e. systems, which may be members of the ETIS Network.

Step 12.

Perform any validation, harmonisation and merging of the data, as necessary. Then, *organise the data in the data-centric modules of the system*. Carefully determine if there is a need for accessing remote data *on demand*; if so, create the necessary procedures. Moreover, determine the *confidentiality resolution procedures*, and program in the system the corresponding components. At the same time, *organise the procedures for updating the data* (since this operation may actually influence the overall data organisation). If necessary, make any required adjustment to the structure of the system components, which are used for the realisation of the modules of ETIS.

Step 13.

Systematically acquire or create the meta-information, which will be necessary for the proper operation of the system. Moreover, determine and acquire the Knowledge (know-how), which has to be put in the system, in order to support the operation of the system and the decision making process. *Organise the meta-information and the necessary knowledge in the system and link it to the data and the processing methods*.

Step 14.

Complete the construction of the system components, *integrate the system and perform tests for assuring its proper operation and evaluating its performance*. Make any corrections that may be necessary.

Step 15.

If necessary, *proceed to the actions needed for connecting (integrating or federating) the system to the ETIS Network*. The kind of connection (e.g. how tight or loose this connection has to be) would highly depend on the exact aim of the individual system under construction and the general ETIS needs for accessing data and processing methods.

Step 16.

Carefully document any decisions and steps taken for the design and construction of the whole system, starting from the decisions on the issues and problems that the system should deal with, and the data it would contain. This is a vital step for the proper, continual operation of the system, as well as for any update or expansion of it. At this point, it has to be noted that in many cases of handling and merging multi-source data, it is not known beforehand, which are the best (or, for that matter, the possible) processing methodologies for merging and/or for using these data for transport modelling. Therefore, *selected tests, or even a specific pilot may be needed for understanding and validating the manner of using the data and the computing methodologies*. Moreover, in the whole aforementioned algorithmic process for creating an ETIS, it is very important to:

– *Carefully avoid building restrictions in the system. If you have to restrict the system, though, due to budgetary considerations, restrict the data set and not the architectural design, so that you keep open the possibility of expanding the data set later*.
– *Follow the organizational and architectural suggestions presented in the previous chapters of this deliverable*, in order to achieve a *flexible, open and scalable architecture for the ETIS realisation*.
– *Follow a standard software development methodology*, as developed in the field of software engineering; e.g. the standard *ISO 9000-3* for guaranteeing the quality of the software production procedures, or the more general *TickIt* for certifying the quality of the software products.

7. Conclusions and recommendations

As aforementioned, the work in the MESUDEMO project turned out a series of important results. The main results can be summarised as follows:

- A better understanding of the organisational and technical nature of ETIS has been achieved and the corresponding basic concepts have been described.
- A general architecture of an ETIS-type system has been developed, and the main modules of it have been further analysed.
- A novel internal data architecture and the corresponding data model for the Infrastructure Networks and the Flows has been developed; this internal architecture has enhanced capabilities of handling Transport data.
- A realisation methodology for ETIS, which reduces the installation and maintenance costs and permits the open (but controlled) access to its data and processing methods, has been developed. This methodology, moreover, permits the easy construction of third-party additional software for ETIS.
- A concrete need for preparatory work on behalf of the Commission at the European level, in order to achieve the ETIS deployment, has been identified. As a result, corresponding suggestions are made to the Commission.
- Moreover, a step-wise, practical path to a future ETIS has been envisaged and described.

Additionally, the Transalpine Research Group has been able to construct the Transalpine Demonstrator, and the working group has been able to construct a viewer for showing the novelties of the proposed architecture; it will be available for downloading from the Web late 2000, and will be combined with extended dissemination material concerning MESUDEMO.

The successful completion of the work is due to two reasons mainly:

(a) The harmonious co-operation of experts in Information Technology with Transport experts, and

(b) the possibility to have the first realistic and practical pilot towards the creation of an ETIS system, namely the Transalpine Pilot. This pilot action did help, in a unique way, the researchers of MESUDEMO to understand many of the concepts and issues related to ETIS.

Any further activity towards ETIS both at European and National level has to be organised in a very serious and thorough way, and be guided by the experience from the Transalpine Pilot and the MESUDEMO project. As far as the technical form of ETIS and the corresponding organisational matters are concerned, the results can guarantee a technically sound, effective and economical realisation of ETIS and a graceful and controlled deployment of the ETIS Network; moreover they can motivate the production of third party software for ETIS. Concluding the following statements could summarise the outstanding project results in suggesting a methodology to implement an ETIS system:

- Identification and understanding of the concepts related to ETIS, the possible form and overall architecture (e.g. the ETIS network, the skeleton of an ETIS, etc.), the differences from the National Systems, etc.
- Identification of the information (transport, socio-economic, behavioural, or other data) needed for inclusion in an ETIS

- First analysis of the architectural needs and formulation of a flexible architecture and advanced internal data models for ETIS, able to cope with the rapidly changing social and technical environment.
- Determination of a step-wise, practical “Path to ETIS”, i.e. a form of algorithm for creating ETIS systems.
- A first analysis of realisation methods for an open, scalable, adaptable and sharable ETIS.
- Identification the pressing problems at the European level, which require an ETIS, and setting priorities for them.
- Preparation for the integration of the most common needed data for all Europe (typology according to the problems, minimum common data sets and complete data dictionaries at the European level, nomenclature and necessary standards, procedures for the creation, harmonisation, merging of the most basic data sets, creation of acquisition paths, etc.)
- Identification of the needed models and processing methods, according to the problems.
- Pilot development of selected ETIS(s), possibly by extending the Transalpine Pilot and/or performing other possible Pilots. Necessary conditions: The systems must face real problems of the corresponding areas and use real data sets. The establishment of permanent data-paths from the producers of the primary data, preferably, to ETIS, is absolutely necessary.
- Development of the software infrastructure for the ETIS realisation and federation into the “ETIS network”. Tackling problems like ownership and confidentiality of data, permitting and promoting third-party software and data set integration, etc.
- Establishment of a first “ETIS network”, by federating the first ETIS.

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9. Terms and list of abbreviations

The glossary terms or abbreviations, which are briefly explained in this table, are in bold letters in the first column. The whole table is organised in an ascending alphabetical order of the keys.

ATIS	Alpine Transport Information System for decision support: a localised ETIS (see corresponding entry).
Conceptual level of the design of an Information System	The design of the whole Information System at a functional level, independently from the software and hardware, which will be used
Data Model vs. Transport Model	"Data model" is an information technology term and signifies the internal data structure of an information system. The term "Data model" is completely irrelevant to the well-known to the transport experts term "Transport model".
DHTML	Dynamic Hyper Text Markup Language. DHTML combines HTML, style sheets, and scripts to make Web pages more interactive and permits an elementary computational ability
DSS	Decision Support System
ETIS	European Transport Information System for Policy support.
ETIS Network	A network of ETIS-type systems, comprising any localised sub-systems (or observatories) working at a regional, but multi-national level, as well any European-level (supra-national) sub-systems. These systems should be compatible in the way they are handling their data and processing methods (including models) and *federated*, in order to provide uniform access to them.
GIS	Geographical Information System
HTML	Hypertext Mark-up Language: It is the hypertext (see relative entry) "language" for the Web (which includes marks for the formatting of the text).
Hypertext	A text format, in which links to other pieces of text of the same or other documents can be included; use of these links brings up directly the linked text. An example of this is the "HTML" format that the Web uses.
IS	Information System
Issue-relevance	The way of organising diverse and polymorph information according to its relevance to the main issues, to which an Information System is called to provide answers (in the case of ETIS, Transport or Policy issues). This term is introduced in this document for the first time.
Layer (in a GIS)	A "plane" of a conventional GIS for showing thematically similar data, which usually are at the same Level-of-Detail. E.g., A plane with the roads, another with the rail, another with the regions, etc.
Localised ETIS	An ETIS used for *local planning*, i.e. for working on problems specific to a *multi-national, but restricted* (i.e. not pan-European) area (see ch.2.2.2)
Logical level of the design of an Information System	The design of the whole Information System with a given data modelling technique, independently from the actual software packages and hardware, which will be used.
Logical vs. Physical sub-set of data	A physical sub-set of data is meant as a separate dataset on a storage medium; a logical sub-set is one that actually lies in a larger, organised

	set of data and is distinguished from the rest of the data either by using specific pointers, which are pointing to these data, or by providing a proper selection method. The logical sub-set can easily be extracted and stored on a medium, or organised in a separate database; in such a case, it becomes physical.
Meta-Information	Information about some other information (usually the data of a system). Meta-information usually describes the meaning and structure of this other information.
Meta-Information Server	The server (programme or computer), which provides meta-information
Module-External Meta-data	The meta-data, which refer to the data of a module, but are stored *outside* this module (e.g. in a knowledge base)
Module-Internal Meta-data	The meta-data, which refer to the data of a module, and are stored *inside* this module (e.g. in an internal sub-module for handling of this information)
Multi-scale networks	Networks containing information in several Levels-of-Detail (LoDs). Special architecture are necessary for organising, storing and inter-relating the information in such networks.
O-O	Object-oriented (technology, programming, etc.)
Partial attributes (mainly related to the links and nodes the transport networks)	Attributes which can be assigned to a part only of a link of a network
Physical level of the design of an Information System	The complete design of the Information System, down to the individual variables and programming sub-modules
Polymorph data	Data, for which more than one forms and formats, are allowed in a system. In order to use these data, the user must explicitly or implicitly (through the *issue-relevance*, see the corresponding entry in the glossary) select a proper form and format for them.
Polymorphy	The existence of *polymorph data* in a system (see the corresponding entry in the glossary). Special techniques are usually needed for handling polymorphy.
Realisation of an Information System	The actual construction of the Information System.
Specific views of (sub)sets of data	When a database contains information in many forms and formats (polymorph data), it is the user needs that defines which of these forms and formats have to be used by the user. Therefore, a mechanism is needed for properly selecting the forms and formats that the user needs, creating thus a specific, logical or physical (see "logical level …" and "physical level …"entries in the glossary) "view" of the data or a sub-set of them. These data can then be exported to a new dataset or database, if needed.
Structured Data (or Information)	Data have a fixed form and format
System-oriented Meta-data	Structured information, which describes the data in a data set or a database; it includes a definition of each datum, as well as a description of its form and format. This information is essential in creating easily maintained, multi-level systems and in permitting different systems to co-operate. *The internal meta-data are provided for the use of the system, since this way certain of its operations can be further automated*. (This

	term is introduced in this document for the first time.)
TIS	Transport Information System.
Unstructured Data (or Information)	The data, whose structure does not have to be necessarily known beforehand, and thus, allow the user a considerable flexibility in choosing the type and format of this information. Usually this term is contrasted to information organised in a fixed way in tables, records, or other structures used in databases.
User-Oriented Meta-Information	Unstructured (see relative entry), additional information or knowledge, related to certain data. This may include any additional documentation, regulation, comment or relative knowledge. *The external Meta-data are provided for the use of the expert user of the system*, in order to help him better understand what he can do with the data, the quality of them, how he can further use them, etc. (This term is introduced in this document for the first time.)
Virtual Database	A database, in which the dataset is actually distributed over more than one, possibly remote, computers. However, its users access the virtual database as if all the data were "local".
Web browser	Web browser is the interface to the World Wide Web. It can follow hypertext links and let the user visit Internet sites and navigate from one Internet machine to another.
Web-enabled user interfaces	User Interfaces that permit transactions to the systems over the World Wide Web

10. Appendices

10.1 Goods transport indicators

The corresponding work was developed in three stages:
1. Definition of relevant indicators to constitute the database on goods flows.
2. Development of methodology for a new statistical framework
3. Pan-European extension of the methodology for a general database on goods flows.

The specific fields of investigation are the goods transport demand indicators of ETIS that are needed to describe the volume and structure of transport generated by the different mobility actors. The selected indicators are listed below in a uniform way, including the label, the unit of measurement, observational unit and priority level in accordance with the INFOSTAT recommendations. The operational definitions leading to a policy oriented comprehensive database structure are described in table 10.1.

Table 10.1: Refined INFOSTAT goods transport demand indicators

No.	**Label**	**Unit of measurement**	**Observational unit**	**Priority level**
1.	Total annual interzonal goods transport flow by commodity group, mode (or combination of modes) and type of transport chain	Tonnes/year	O/D pair	F
2.	Average distance between origin and destination of transport unit by mode	Km,	O/D pair	F
3.	Average distance between origin and destination of the good	Km	O/D pair	F
4.	Loading factor (ratio between volume and capacity) per type of transport unit by mode	Per cent	O/D pair (main leg)	D
5.	Annual total number of tonnes transported broken down by • size of shipment (weight) • value of shipment[2)] (ECU) • trip distance (km) • containerisation (yes or no) • type of transport unit	Tonnes/year	O/D pair (main leg)	F
6.	Average number of days of use of the transport unit	Days	Zone	D
7.	Use of EDI, tracing and tracking of shipment	Yes or no	Zone	D

1. Tonne-kilometre figures may be derived when combining 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 (tonne) flows.
3. F = fundamental, D = desirable

Indicator 1

No.	**Label**	**Unit of measurement**	**Observational unit**	**Priority level**
1.	Total annual inter zonal goods transport flow by commodity group, mode (or combination of modes) and type of transport chain	Tonnes/year	O/D pair	F

This indicator is intended to describe the volume and structure of goods flows between the original origin and final destination. Following the INFOSTAT definition transport chain has been defined 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. As such direct flows of goods may be regarded as a transport chain without transhipment"*.

A transport chain with a single transshipment node (point in space) could be represented in a database record structure as follows:

1. *Zone of original origin of goods flow (o)*
2. *Zone of final destination of goods flow (d)*
3. *Zone of transshipment (n)*
4. *Mode from original origin to node of transshipment (m1)*
5. *Mode from node of transshipment to final destination (m2)*
6. *Commodity group (g)*
7. *Weight transported in tonnes (TT)*

In mathematical notation**:** $TT_{o, d, n, m1, m2, g}$

Indicator 2

No.	**Label**	**Unit of measurement**	**Observational unit**	**Priority level**
2.	Average distance between origin and destination of transport unit by mode	Km	O/D pair	F

This indicator could be interpreted as the infrastructure network distance with choice of shortest, cheapest or fastest route between two regions. Transport time and cost could also be calculated in a similar way. The term transport unit is explained in table 5.2. Indicator 2 could be represented as follows in a database record structure:

1. *Zone of loading of transport unit (i)*
2. *Zone of unloading of transport unit (j)*
3. *Transport mode (m)*
4. *Transport unit (u)*
5. *Average distance in kilometre (DT)*

In mathematical notation**:** $DT_{i, j, m, u}$

If distance is calculated from available O/D-data in transport statistics on both weight transported (tonnes) and transport performance (tonne-kilometres), transport distance could be represented in a database record according to:

1. *Zone of loading of transport unit (i)*
2. *Zone of unloading of transport unit (j)*
3. *Transport mode (m)*
4. *Transport unit (u)*
5. *Weight transported in tonnes (TT)*
6. *Transport performance in tonne-kilometres (TK)*
7. *Average distance in kilometres (DT) = 6/5*

In mathematical notation**:** $DT_{i,j,m,u}$

$DT_{i,j,m,u} = (TK_{i,j,m,u})/(TT_{i,j,m,u})$

Indicator 3

No.	**Label**	**Unit of measurement**	**Observatio-nal unit**	**Priority level**
3.	Average distance between origin and destination of the good	Km	O/D pair	F

Just as for indicator 2 it seems justified to relate this indicator to transport performance in a transport chain, which could be calculated from available O/D- (chain-) data on tonnes transported and tonne-kilometres. For a transport chain with a single transshipment node the average distance could be represented as follows in a database record structure:

1. *Zone of original origin of goods flow (o)*
2. *Zone of final destination of goods flow (d)*
3. *Zone of transshipment (n)*
4. *Mode from original origin to node of transshipment (m1)*
5. *Mode from node of transshipment to final destination (m2)*
6. *Weight transported in tonnes (TT)*
7. *Transport performance in tonne-kilometres (TK)*
8. *Average distance in kilometres (DT) = 7/6*

In mathematical notation**:** $DT_{o, d, n, m1, m2}$
$DT_{o,d,n,m1,m2} = (TK_{o,d,n,m1,m2}) / (TT_{o,d,n,m1,m2})$

Indicator 4

No.	Label	Unit of measurement	Observational unit	Priority level
4.	Loading factor (ratio between volume and capacity) per type of transport unit by mode	Per cent	O/D pair (main leg)	D

Although this indicator is not seen as fundamental for the transport demand flows, it could give valuable information on the efficiency of transport performance both for transport operators and policy makers. The capacity of a transport unit can be specified in various ways, for instance w*eight carrying capacity (tonnes), volume carrying capacity* (*m*^{3} *or litres), capacity in number of units (TEU's, pallets, length of lanes, etc.).*
A database record with the loading factor (capacity utilisation) could be specified as follows:
1. *Zone of loading of transport unit (i)*
2. *Zone of unloading of transport unit (j)*
3. *Transport mode (m)*
4. *Transport unit (u)*
5. *Weight transported in tonnes (TT)*
6. *Carrying capacity moved in tonnes (TC)*
7. *Loading factor (LF)*

In mathematical notation**:** $LF_{i,j,m,u}$

$LF_{i,j,m,u} = (TT_{i,j,m,u}) / (TC_{i,j,m,u})$

Indicator 5

No.	Label	Unit of measurement	Obser- vational unit	Priority level
5.	Annual total number of tonnes transported broken down by size of shipment (weight), value of shipment[2)] (ECU), trip distance (km), containerisation (yes or no) and type of transport unit	Tonnes/year[1)]	O/D pair (main leg)	F

1. Tonne-kilometre figures may be derived when combining 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 (tonne) flows.

A database record with these specifications could be represented as follows:

1. *Zone of loading of transport unit (i)*
2. *Zone of unloading of transport unit (j)*
3. *Transport mode (m)*
4. *Transport unit (u)*
5. *Shipment weight class (s)*
6. *Shipment value class (v)*
7. *Trip distance class (d)*
8. *Cargo type (c)*
9. *Weight transported in tonnes (TT)*
10. *Value transported in Euro's (VT)*

In mathematical notation**:** $TT_{i, j, m, u, s, v, d}$ and $VT_{i, j, m, u, s, v, d}$

Indicator 6

No.	Label	Unit of measurement	Observational unit	Priority level
6.	Average number of days of use of the transport unit	Days	Zone	D

This indicator is intended to describe the availability of the transport unit. In combination with other freight transport supply and demand indicators a global figure might be calculated to monitor the capacity situation in the various transport markets. A database record with these specifications could be represented as follows:

1. *Zone of registration (z)*
2. *Transport mode (m)*
3. *Transport unit (u)*
4. *Carrying capacity class (tc)*
5. *Number of transport units (TU)*
6. *Average weight carrying capacity (ATC)*
7. *Average number of hours of use (H)*

Indicator 7

No.	Label	Unit of measurement	Observational unit	Priority level
7.	Use of EDI, tracing and tracking of shipment	Yes or no	Zone	D

It is hard to find a meaningful interpretation for this INFOSTAT indicator if the observational unit is a zone. From the point of view of freight transport demand it should say something about the use of EDI and tracking and tracing of individual shipments. What zone should be taken for the aggregation of this shipment related information, the origin, the destination or perhaps the transhipment zone? It seems more appropriate to aggregate to an O/D-relation with perhaps further specification of the kind of shipment as for indicator 5. Because this indicator is not seen as fundamental, it will not be treated as a separate indicator, but can be treated as part of indicator 5.The indicators described above can be considered as belonging to four different groups or levels of information, ranging from the goods flow in transport means (mode and unit), the trip, the load (consignment) and the transport chain. These groups are closely related (linked) to each other. The following aspects should be kept in mind before linking transport information:

1. A harmonised classification should be used to be able to keep hold of the most detailed information possible, such as information on the load (consignment)
2. Individual items should be considered as new variables, such as number of trips, number of consignments, etc.
3. Some additional variables should be calculated, e.g. weight x consignment distance for tonne-km, capacity x (loaded and/or empty) trip distance, etc.
4. Consistency with classification used in trade databases for building transport chains
5. Consistency with classification used in other parts of ETIS (socio-economic data, passenger flows, infrastructure links and nodes, impacts).

If aggregate information is used, it will be difficult to produce the required linkages, especially from the load to the transport chain. A reverse scheme must, therefore, be taken into consideration as a way to assemble the different elements of the transport chain, going from the identification of the shipment to the characteristics of the transport movements (trip, mode and transport unit attributes). Information consistent with such a scheme could be compiled through shippers' surveys in the short-term and through shippers' or major transport integrators' EDI systems in the medium/long-term. The drawback would be the cost to collect new information, but the advantage would be the assurance from the beginning that different elements could be linked at a very disaggregate level. At the same time one could also collect information about economic and logistic determinants of transport.

A comprehensive review procedure was used to identify the level of compatibility between the actual proposed indicators and the structure of data available from different sources, but fulfilling a similar purpose. The conclusion from the extensive search for available and relevant statistical information was rather simple. Traditional statistical data on European goods transport flows are mostly restricted to a unimodal registration at an annual basis of tonnes and/or tonne-kilometres broken down by commodity group and only specifying country of origin and country of destination (NUTS 0). The lack of more detailed O/D information is seen as one of the major shortcomings of the existing transport statistics. To test out in some detail the possibility of establishing relevant databases by combining and restructuring available data sets (databases), the Transalpine Pilot Study was carried out.

10.2 Passenger transports indicators

Table 10.2 shows the INFOSTAT indicators that have been made operational in MESUDEMO. As for goods transport some notation principles are used to specify the passenger indicators:

- i = origin zone of a trip
- j = destination zone of a trip
- k = zone of resident population
- l = long-distance
- c = trip chain
- m = transport mode (e.g. passenger car, bus, coach, railway, air plane, ship)
- p = purpose of a trip (e.g. commuting, business, leisure, other)
- w = type of car owner (e.g. privately owned, owned by business)
- d = distance of trips
- t = number of trips
- p = number of passenger-kilometres.

Trip is a basic concept comprising the homogenous part of a journey as to journey purpose. So if a person commuting by car stops on the way to the job to do e.g. some shopping, the journey is split into two trips, each with its definite purpose. Just as in the case of goods transport trips may form a chain. In the example given above commuting by car to the job with one stop for shopping on the way, constitutes two trips in a trip chain. If the journey to work comprised a change of transport mode e.g. car to the railway station and train onwards (park-and-ride), the change of transport mode constitute transshipment in the context used for goods transport. If we try to give strict definitions to the first five indicators in table 10.2, we could identify two different viewpoints or perspectives based on a different understanding of the indicators, as follows:

1. Defining the variables with reference to the trip production by the resident population of zone *k* from each zone *i*, including the residence zone
2. Defining the variables with consideration to the trip production of zone *i*.

The first alternative that is considered to be most reliable, affordable and viable has been chosen.

Table 10.2: INFOSTAT passenger transport demand indicators

No	Label	Unit of measurement	Observational unit	Priority level
1	Total annual number of passenger trips generated by zone population broken down by mode or combination of modes and trip purpose	Trips/year	Zone	F
2	Total annual number of passenger-kilometres generated by zone population broken down by mode or combination of modes and trip purpose	Km/year	Zone	F
3	Total annual number of long-distance trips generated by zone population broken down by mode or combination of modes and trip purpose	Trips/year	Zone	F
4	Total annual number of passenger-kilometres in long-distance transport generated by zone population broken down by mode or combination of modes and trip purpose	Km/year	Zone	F
5	Average distance of passenger trips made by zone population broken down by mode or combination of modes and trip purpose	Km/trip	Zone	F
6	Annual distance travelled per inhabitant of zone by mode or combination of modes and trip purpose	Km/person and year	Zone	F
7	Annual mileage per car registered in zone broken down by type of car owner (private, business)	Km/car and year	Zone	F
8	Average vehicle occupancy rate for trips of vehicles registered in zone broken down by vehicle type and trip purpose	Passengers/ vehicle trip	Zone	F
9	Total annual interzonal passenger transport flow by trip purpose, mode (or combination of modes) and type of trip chain	Passenger trips per year	O/D pair	F
10	Annual total of passenger-kilometres occurring on territory of zone broken down by kind of infrastructure used	Passenger-km per year	Zone	D
11	Annual total of passenger-kilometres occurring on territory of zone broken down by trip distance class (type of day, time of day, type of traffic conditions)	Passenger-km per year	Zone	D

In the following listing of indicators two columns called

1. related variable description
2. variable label

are included in addition to those specified in the INFOSTAT project. Both columns intend to present steps in the process of giving operational content to concepts. The formal symbols used are further elaborated upon at the end of the listing.

Indicator 1

Label for passenger indicator 1	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Total annual number of passenger trips generated by zone population broken down by mode or combination of modes and trip purpose	Number of trips by origin, mode and trip purpose	Trip origin Trip mode(s) Trip purpose	Trips/year	Zone	F

Definition: $T^{k}_{i,m,p}$ number of trips generated by resident population in zone *k* from zone *i*, per mode *m* and purpose *p*, per year

Indicator 2

Label for passenger indicator 2	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Total annual number of passenger-kilometres generated by zone population broken down by mode or combination of modes and trip purpose	Number of passenger/km by origin, mode and trip purpose	Trip destination Trip distance Trip origin Trip mode(s) Trip purpose	Km/year	Zone	F

Definition: $P^{k}_{i,m,p}$ number of passenger-kilometres generated by resident population in zone *k* from zone *i*, per mode *m* and purpose *p*, per year

Indicator 3

Label for passenger indicator 3	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Total annual number of long-distance trips generated by zone population broken down by mode or combination of modes and trip purpose	Number of long-distance trips by origin, mode and trip purpose	Long-distance: trip origin trip mode(s) trip purpose	Trips/year	Zone	F

Definition: $T^{l,k}_{i,m,p}$ number of long-distance trips generated by resident population in zone *k* from zone *i*, per mode *m* and purpose *p*, per year

Indicator 4

Label for passenger indicator 4	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Total annual number of passenger-kilometres in long-distance transport generated by zone population broken down by mode or combination of modes and trip purpose	Number of passengers/km in long-distance trips by origin,mode and trip purpose	Long-distance: destination distance origin mode(s) purpose	Km/year	Zone	F

Definition: $P^{l,k}_{i,m,p}$ number of passenger-kilometres of long distance trips generated by resident population in zone *k* from zone *i*, per mode *m* and purpose *p*, per year

Indicator 5

Label for passenger indicator 5	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Average distance of passenger trips made by zone population broken down by mode or combination of modes and trip purpose	Average distance of passenger trips by mode(s) and purpose	Trip length (km) Trip length by mode(s) Trip length by purpose	Km/trip	Zone	F

Definition: $D^{k}_{i,m,p}$ average distance of trips generated by resident population in zone *k* from zone *i*, per mode *m* and purpose *p*, per year

Indicator 6

Label for passenger indicator 6	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Annual distance travelled per inhabitant of zone by mode or combination of modes and trip purpose	Total km travelled per inhabitant by origin, mode(s), purpose	Total km travelled Total km travelled by mode(s) Total km travelled by purpose	Km per person and year	Zone	F

Definition: $DKM_{i,m,p}$ total km travelled per inhabitant of zone *i*, per mode *m* and purpose *p*, per year

Indicator 7

Label for passenger indicator 7	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Annual mileage per car registered in zone broken down by type of car owner (private, business)	Annual km per car by zone, by ownership	Annual km/car by area Annual km/car by ownership	Km/car and year	Zone	F

Definition: $DCAR^{w}_{i}$ annual mileage per car registered in zone *i*, per type of car owner *w*, per year

Indicator 8

Label for passenger indicator 8	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Average vehicle occupancy rate for trips of vehicles registered in zone broken down by type of car owner and trip purpose	Average vehicle occupancy rate by zone, by ownership	Average vehicle occupancy by area Average vehicle occupancy by ownership	Passengers/ vehicle trip	Zone	F

Definition: $OCC^{w}_{i,p}$ average vehicle occupancy rate of vehicles registered in zone *i*, per type of car owner *w* and purpose *p*, per year

Indicator 9

Label for passenger indicator 9	Related variable description	Variable	Unit of measurement	Observational unit	Priority level
Total annual interzonal passenger transport flow by trip purpose, mode (or combination of modes) and type of trip chain	O/D flows by trip purpose, mode(s)	O/D flows by mode(s) O/D flows by trip purpose	Passenger trips per year	O/D pair	F

Definition: $T_{i,j,m,p}$ total number of trips generated by origin zone *i* and attracted by destination zone *j*, per type of trip chain, mode *m* and purpose *p*, per year

Indicator 10

Label for passenger indicator 10	**Related variable description**	**Variable**	**Unit of measurement**	**Observational Unit**	**Priority level**
Annual total of passenger-kilometres occurring on territory of zone broken down by kind of infrastructure used	Not relevant	Not relevant	Passenger-km per year	Zone	D

Definition: Not relevant.

Indicator 11

Label for passenger indicator 11	**Related variable description**	**Variable**	**Unit of measurement**	**Observational unit**	**Priority level**
Annual total of passenger-kilometres occurring on territory of zone broken down by trip distance class (type of day, time of day, type of traffic conditions)	Not relevant	Not relevant	Passenger-km per year	Zone	D

Definition: Not relevant.

Indicators 10 and 11 have been considered not relevant in the context of the origin and destination framework that has been basic to this chapter.

Variables can be sorted in independent and dependent variables, e.g. as follows:

Independent variables

$T^{k}_{i,m,p}$ number of trips generated by resident population in zone *k* from zone *i* per mode *m* and purpose *p*, per year

$T^{l,k}_{i,m,p}$ number of long-distance trips generated by resident population in zone *k* from zone *i* per mode *m* and purpose *p*, per year

$D^{k}_{i,m,p}$ average distance of trips generated by resident population in zone *k* from zone *i* per mode *m* and purpose *p*, per year

$DKM_{i,m,p}$ total km travelled per inhabitant of zone *i* per mode *m* and purpose *p*, per year

$DCAR^{w}_{i}$ annual mileage per car registered in zone *i*, per type of car owner *w*, per year

$OCC^{w}_{i,p}$ average vehicle occupancy rate of vehicles registered in zone *i*, per type of car owner *w* and purpose *p*, per year

$T_{i,j,cm,p}$ total number of trips generated by origin zone *i* and attracted by destination zone *j*, per type of trip chain *c*, mode *m* and purpose *p*, per year, for $i \neq j$

Dependent variables

$P^{k}_{i,m,p}$ number of passenger-kilometres generated by resident population in zone *k* from zone *i* per mode *m* and purpose *p*, per year

$P^{l,k}_{i,m,p}$ number of passenger-kilometres of long distance trips generated by resident population in zone *k* from zone *i* per mode *m* and purpose *p*, per year

Further some relationships between dependent and independent variables can be identified:

Relationships

$$P^{k}_{i,m,p} = T^{k}_{i,m,p} * D^{k}_{i,m,p}$$

$$P^{l,k}_{i,m,p} = T^{l,k}_{i,m,p} * D^{l,k}_{i,m,p}$$

Variable $D^{l,k}_{i,m,p}$ is defined as average distance of long-distance trips generated by resident population in zone *k* from zone *i* per mode *m* and purpose *p*, per year. Values can be calculated from the $D^{k}_{i,m,p}$, based on the definition of long-distance trip. The demand both on data and on functionality of the future ETIS strongly depends on the requirement of defining not only a procedure for database creation, but also on a reliable maintenance procedure with flexibility to include new data sets and new layers as needs arise.

Figure 7.1 Structure of road freight flows crossing the Brenner

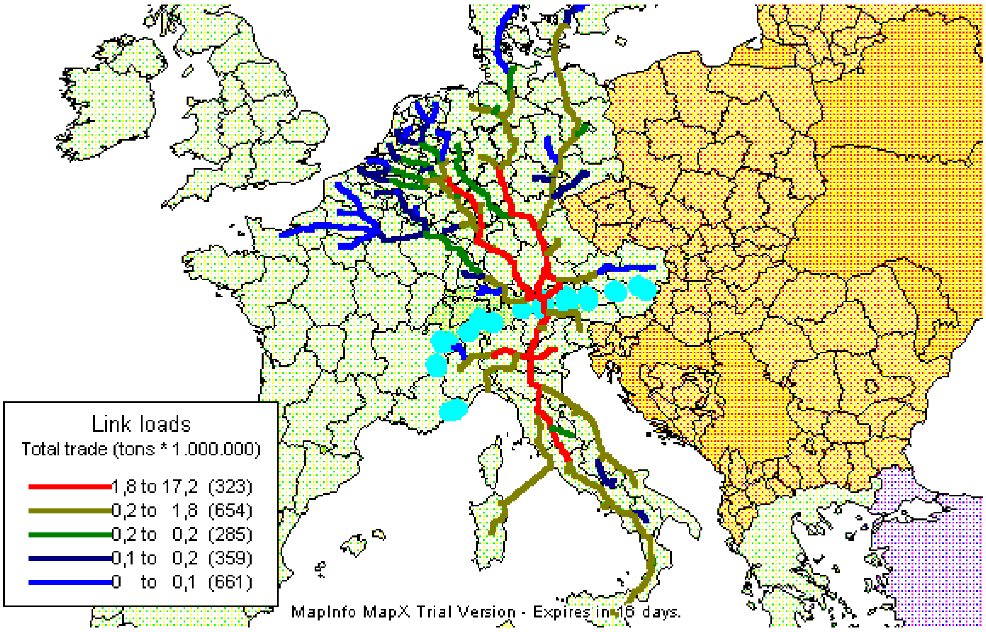

Figure 7.2 Structure of road freight flows crossing the Mont Blanc

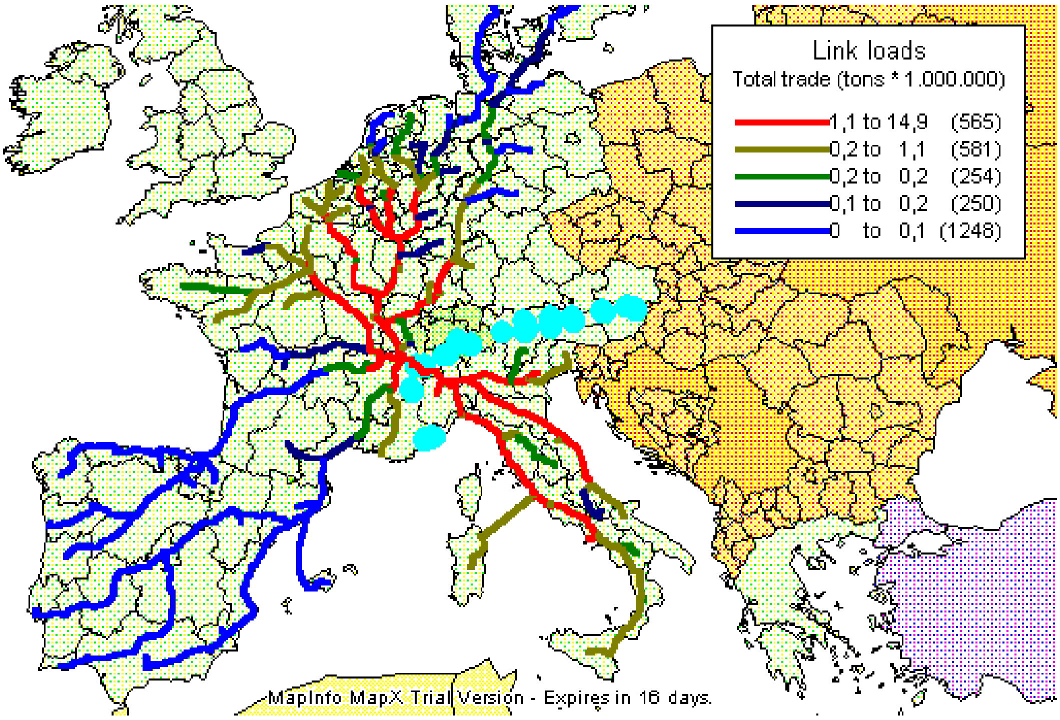

Figure 7.3 Structure of road freight flows crossing the Gotthard

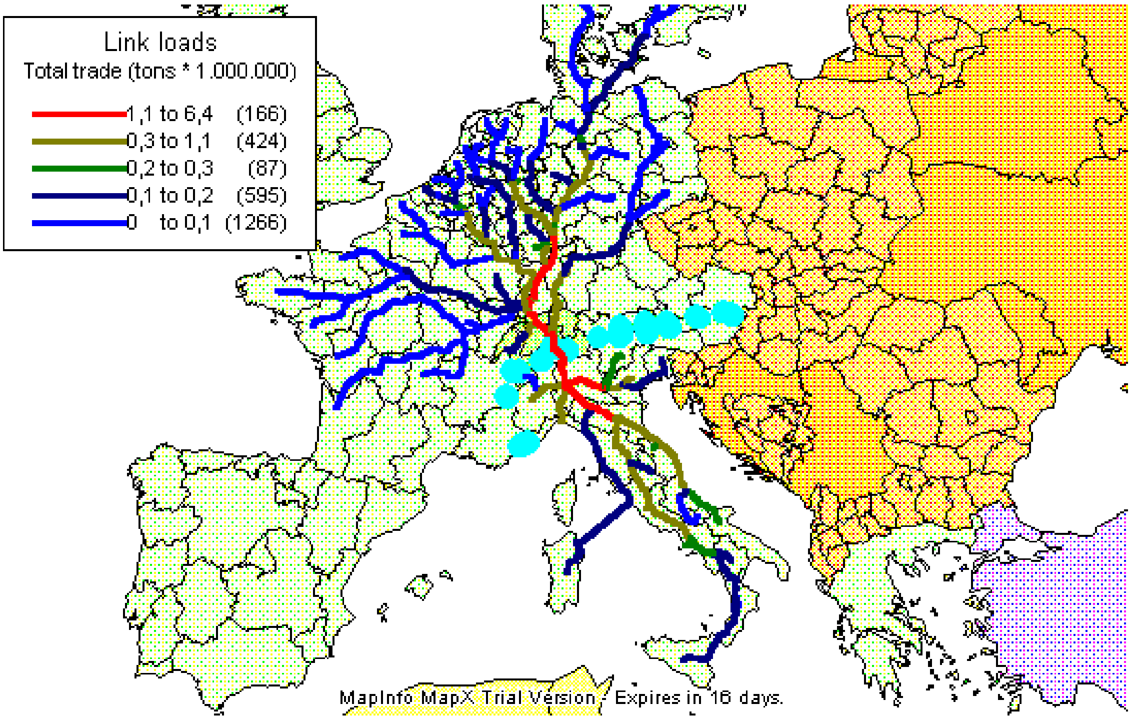

Figure 7.4 Pattern of road freight flows from The Netherlands to Italy, by region

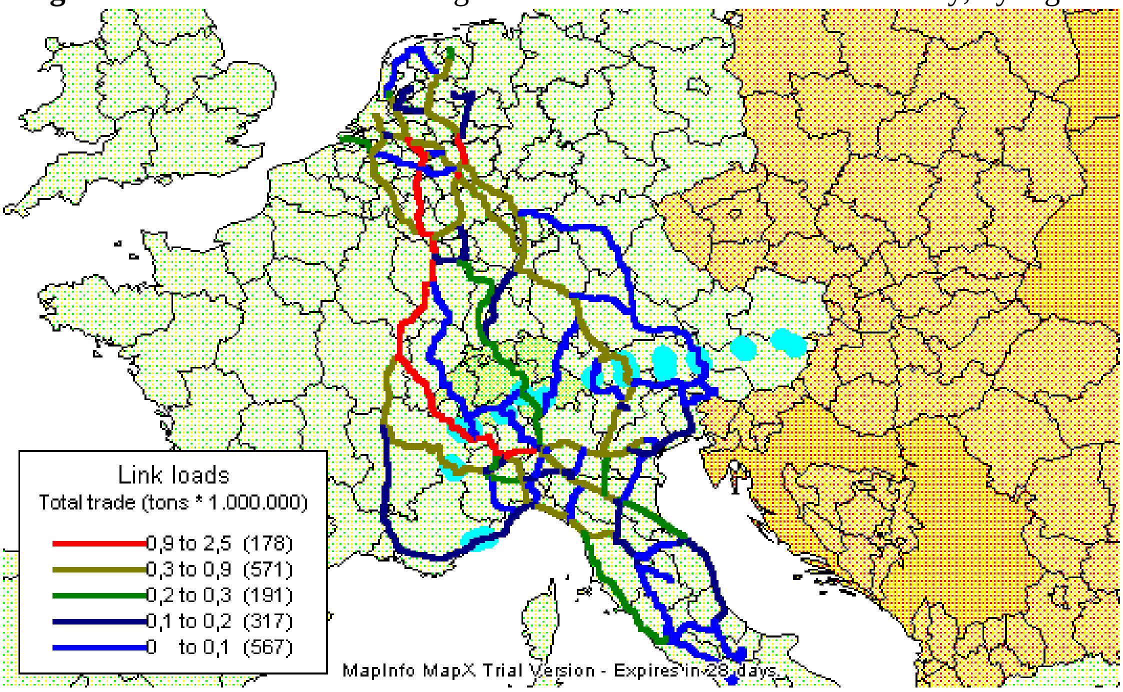

Figure 7.5 Pattern of road freight flows from Rotterdam to Milano regions

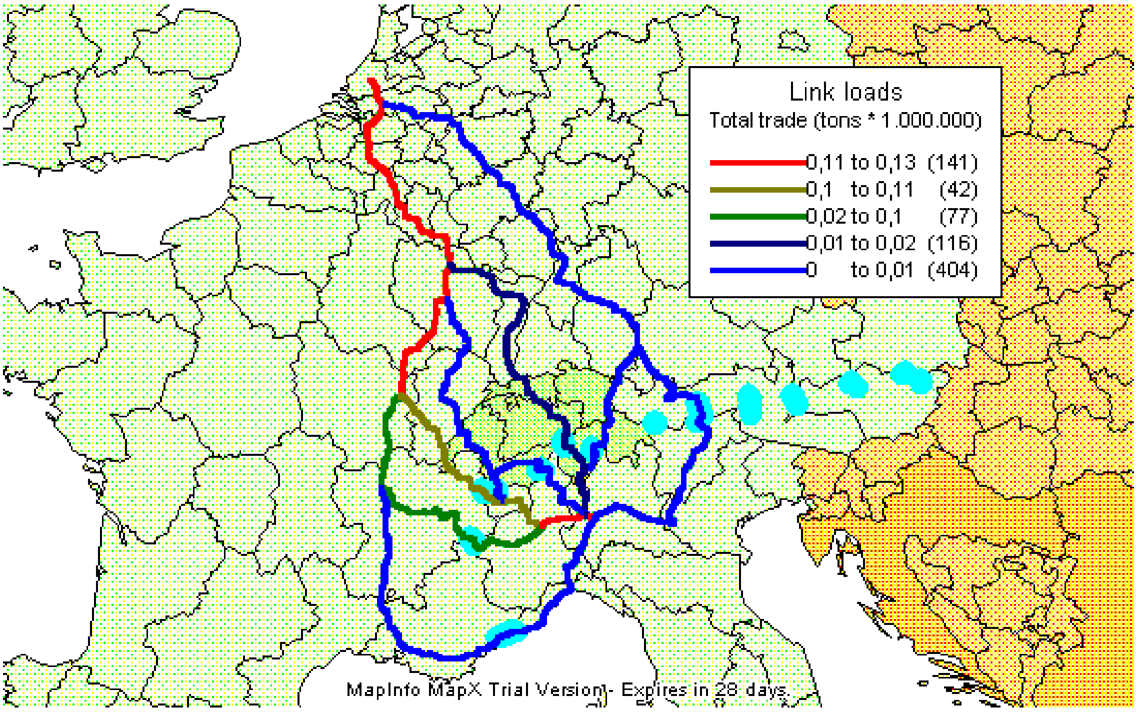

Figure 8.1.1 Change on road freight traffic flows when closing Brenner

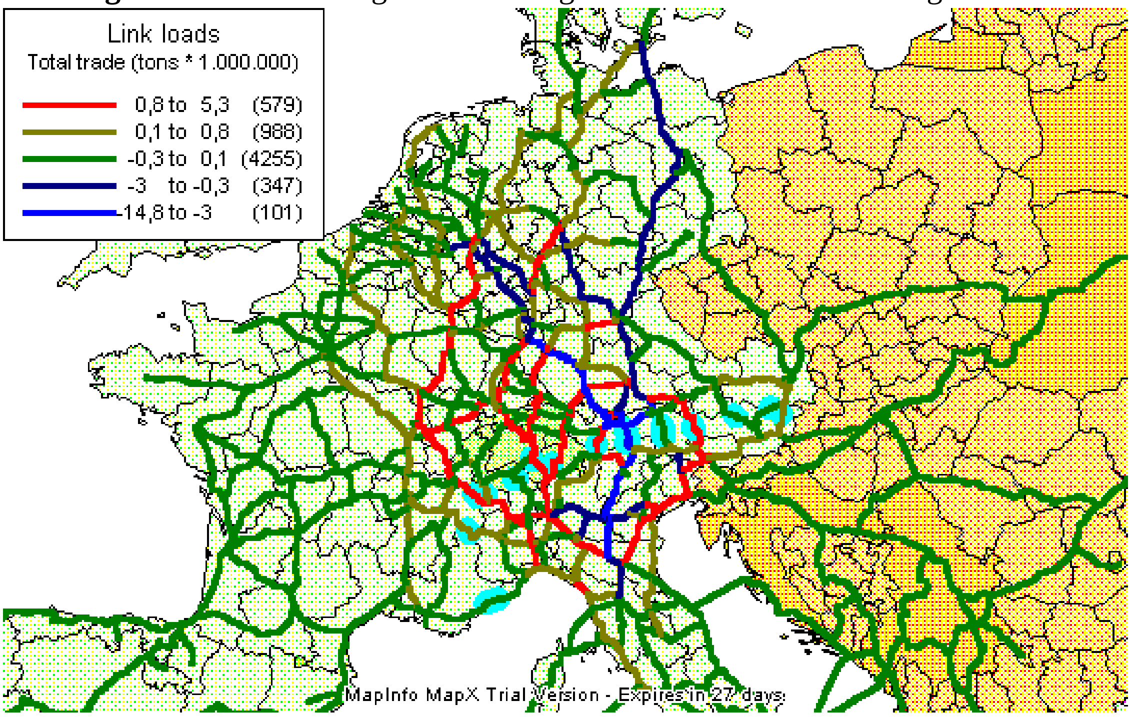

Figure 8.1.2 Change on road freight traffic flows when closing Mont Blanc

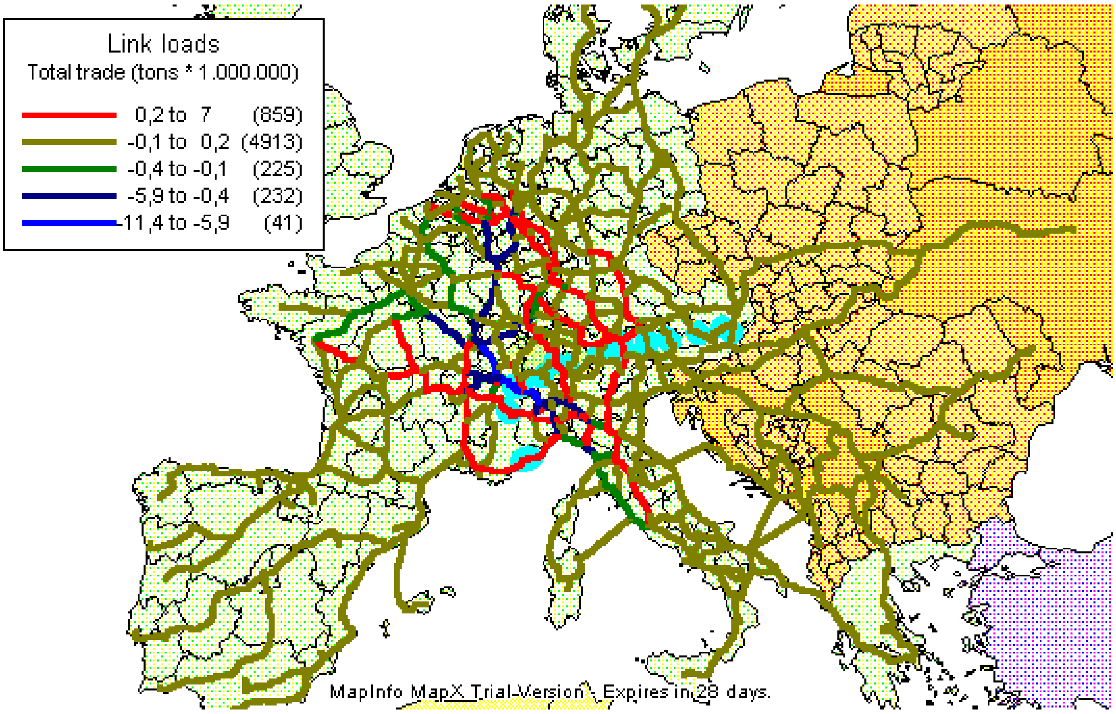

Figure 8.2.1 Impact of Swiss road toll of 2 EURO per ton on road traffic flows

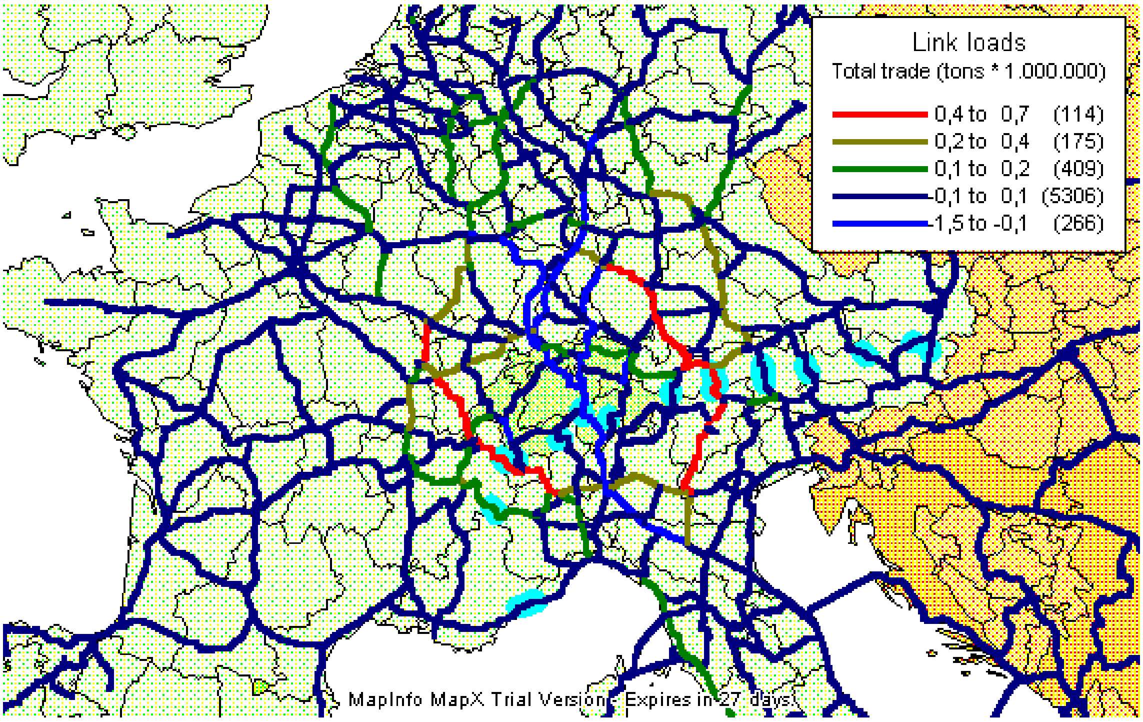

Figure 8.2.2 Impact of Swiss road toll of 5 EURO per ton on road traffic flows

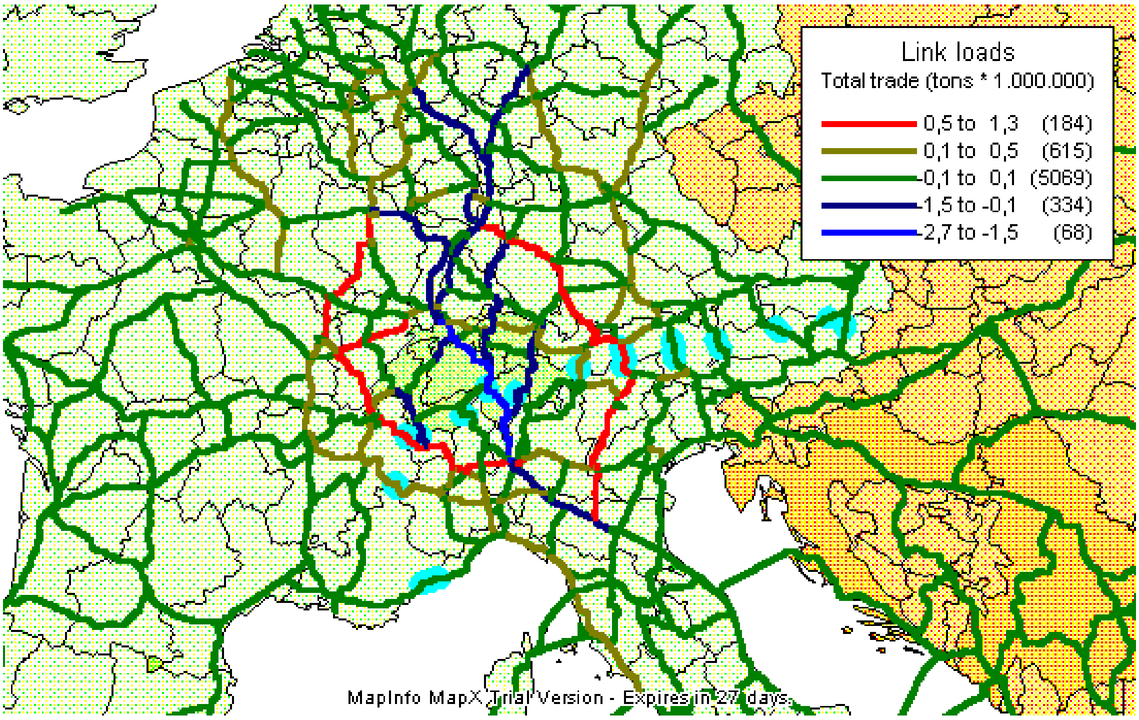

Figure 8.2.3 Impact of Swiss road toll of 10 EURO per ton on road traffic flows

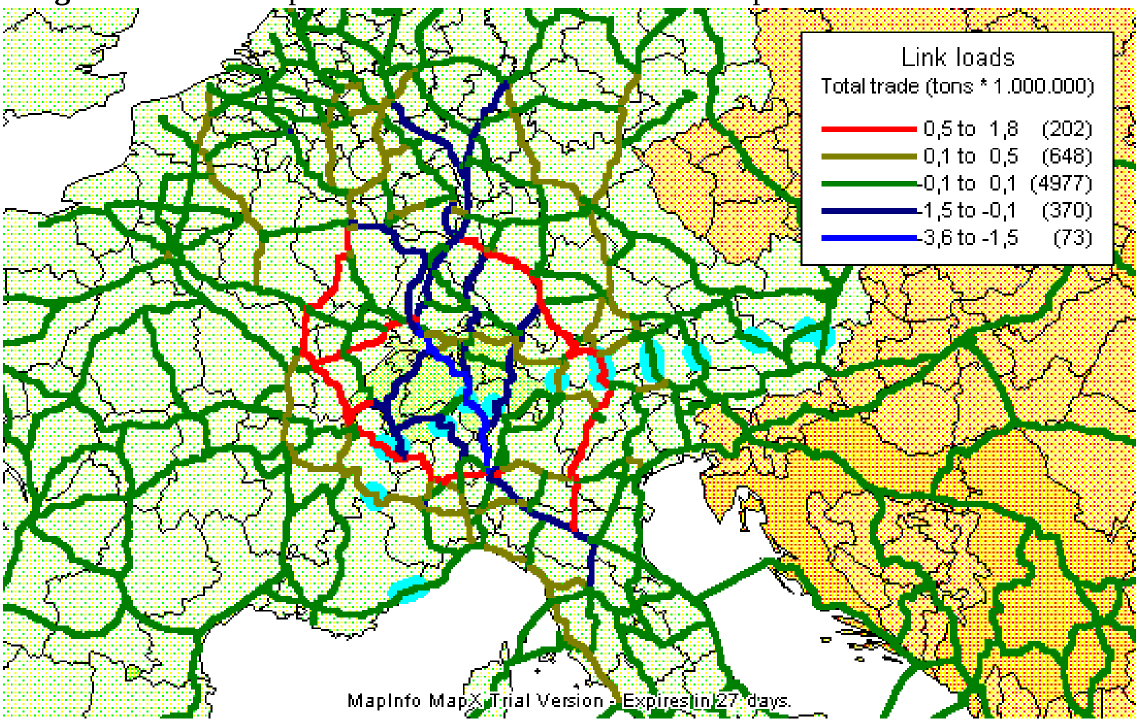

Figure 8.2.4 Impact of Swiss road toll of 15 EURO per ton on road traffic flows