PROGRAMMA 'DUURZAME MOBILITEIT'
DIENSTEN VAN DE EERSTE MINISTER
FEDERALE DIENSTEN VOOR WETENSCHAPPELIJKE,
TECHNISCHE EN CULTURELE AANGELEGENHEDEN

Eindverslag

Onderzoeksproject: MD/DD/01
Contract nummer: MD/04/001

Naar een duurzame mobiliteit: economische en ruimtelijke effecten van een toenemend goederenvervoer

Eindverslag van de onderzoeksgroep UFSIA:
onderzoeksperiode 1/7/1997-30/6/2001

Promotoren: Prof. Dr. H. Meersman
Prof. Dr. E. Van de Voorde
Prof. Dr. A. Verhetsel

Onderzoeksmedewerker: Drs. T. Pauwels

Juni 2001

TOWARDS SUSTAINABLE MOBILITY:
ECONOMIC AND SPATIAL EFFECTS OF INCREASING GOODS TRAFFIC

(Project MD/DD/01)

FINAL REPORT UFSIA

(contract number MD/04/001)

1. Introduction

The project of the research team, made of researchers of UFSIA, UCL and GTM-FUCAM is to analyse the impacts of freight transports in a spatial and multimodal framework. As transports are made over a non-uniform space, it is indeed necessary to take into account the characteristics and the density of infrastructure and of the supplied transport services. Furthermore, one should also take into account the mode choices which are made and which determine to a large extent the external effects of transports. The qualifications of the team members indeed permit to approach these problems by different ways. In this report we present the results of the UFSIA research team.

Freight and passengers transports are the source of many negative impacts on society. These are matters of serious concern because they threaten the sustainable economic development of Belgium and Europe, as well as of the whole world. These effects of transports not only reduce the real productivity of our economies, but raise serious questions about their capacity to keep functioning unchanged and about the future welfare of the populations. Thus, it is important to identify and measure all these negative effects: the pollutants, noise, accidents, time lost on congested networks, damages to the roads. It is also crucial to investigate the available means for limiting these impacts in order to permit a sustainable economic development and a growing welfare of the populations.

On the one hand, mobility of goods as well as of persons is a necessary condition for economic growth, wealth and welfare. On the other hand it generates negative external effects which might hamper economic activity and harm well being. This duality makes the design of policies, which reduce the external effects of freight transport without impeding economic welfare and economic growth, a hard task. It can only be successful if one has a clear insight in all the factors and mechanisms which have an impact on freight transport, on the negative external effects resulting from freight transport and on the complex network of relations between freight transport, passenger transport and economic activity.

This project has taken up the challenge to gain more insight into this complex relation between freight transport and welfare. It has used the knowledge and experience of the three teams involved. The UFSIA team has investigated, on the one hand, how companies and shippers of goods choose a transportation mode (road, rail, inland navigation or combinations) and how this choice can be influenced . On the other hand, it has looked into the question of how freight mobility has an impact on (regional) economic growth. The UCL/UFSIA team has analysed the role of infrastructure for sustainable freight mobility. FUCAM has developed a very detailed virtual network, which makes it possible to identify the different streams of commodity flows, and the costs generated by freight transport on this network. The combination and integration of the research of the teams results in a better understanding of the complex interrelation among freight transport, infrastructure, costs (external and internal) and economic growth.

The ultimate objective of the project is to get a good grip on the complex relation among freight transport, external effects, infrastructure and economic growth. Within the project each team had its own targets which were necessary for reaching that final objective.

- The goals of the UFSIA-team were fourfold:
  - to study the external effects generated by freight transport;
  - to analyse the factors that affect the choice of freight transport modes and how changes of these factors, such as costs, will change the behaviour of shippers and companies;
  - to quantify the impact of internalising the external costs on freight transport and on the mode choice;
  - to start research on the impact of freight transport on economic activity.

2. Methodology

Designing policies for sustainable mobility can only be successful if one has a clear understanding of the factors that affect the behaviour of all the agents involved in transport. This project has focused its attention on freight transport. In order to be able to quantify the external effects generated by freight transport and to design policies to reduce negative external effects, the following elements needed to be investigated:

1) given the actual infrastructure and the actual mode choice, what and how big are the external effects of freight transport;
2) how can the infrastructure be adapted to guarantee freight flows with a minimal amount of externalities;
3) how can freight flows be shifted from socially expensive modes to socially less expensive modes (or combinations of modes);
4) how can freight flows be re-routed towards socially less expensive routes.

Answering these questions requires research on mode and route choice, on optimal changes of and investment in infrastructure, and a fairly detailed network model to quantify the freight flows and the external effects. The research teams have each used their specific knowledge and expertise to solve the above questions.

3. Results

3.1. The activities of the UFSIA research team

The activities of the UFSIA research group can be divided into 4 categories: formulating definitions, a literature review, the analysis of available transport data and modelling the mode choice.

(1) Formulating the definitions

Within this part of the research, an overview of the relevant definitions and terminology was gathered. The analysis can be found in: T. Pauwels (1998), Aspecten van de vraag naar goederenvervoer: modale keuze en modale uitsplitsing, Hoofdstuk 2: De vraag naar modi in het goederenvervoer: theoretische achtergrond, p. 19-31.

(2) Literature review

The literature review gives an overview of empirical papers which study aspects of the demand for freight transport, with an emphasis on the demand for transport modes. The publications are categorised in several topics and judged on their contributions and shortcomings (T. Pauwels (1998), Modale keuze en modale uitsplitsing in het goederenvervoer: een literatuuroverzicht, p. 1-34). Parallel with the literature review of the empirical papers, a description has been made of the frequently used models in the literature (T. Pauwels (1998), Aspecten van de vraag naar goederenvervoer: modale keuze en modale uitsplitsing, Hoofdstuk 3: De vraag naar modi in het goederenvervoer: modelmatig, p. 32-48). Finally, conclusions are formulated, based on the literature studied (see further).

(3) A critical analysis of the transport statistics, with a special emphasis on origin-destination data.

An overview was made of the existing statistical material of freight transport on the Belgian infrastructure. Road transport, rail transport and inland navigation were all taken into account. The focus was on the data that were useful in the analysis of mode choice in freight transport. The data that give an indication of origin and/or destination are mentioned in the overview. Drawing on the data that were immediately available, synoptic tables were constructed (national, import, export and transit) for the years 1996 and 1997. Conclusions were formulated in relation to reliability and usefulness (T. Pauwels (2000), Het goederenvervoer in België: een kritische analyse van de transportstatistieken, met een specifieke aandacht voor herkomst-bestemmingsdata, blz. 1-71).

(4) Modelling the mode choice in freight transport

(4.1) Aggregated research

An econometric analysis was made of the mode choice. The analysis used the freight flows between Belgian districts ('arrondissementen'), which means that only national transport was investigated. The data refers to the year 1989 and were obtained from the NIS (National Institute of Statistics) and the NMBS (National Railway Company). The year 1989 is the last year for which comparable, detailed data are available. We refer to the final report of the previous Impulse Programme Transport and Mobility, De Brabander, G., Meersman, H., Gentil, G., Pauwels T. en E. Van de Voorde, Eindverslag (Voortgangsverslag nr. 5). Module B2: Ontwikkeling Modules "Generatie" en "Modal Split" voor goederenverkeer voor Multimodaal Interregionaal Model (MIM): BijlageI: Korte bespreking van de empirische resultaten betreffende de modale uitsplitsing, UFSIA-SESO, Antwerpen, december 1995; Van de Voorde, E., Winkelmans, W. (et al), Aspecten van havencompetitiviteit, Finaal onderzoeksrapport (GOA 1995-1998), p. 169-174, 2000 and a forthcoming paper by Meersman and Van de Voorde on mode choice in freight transport.

(4.2) Company-specific research

The choice of mode is a procedure carried out on the level of the company (producer of goods, forwarding-agent...). It is therefore useful to do the research also on this level, next to that of aggregated research. Especially the effects of internalising the external costs play an important role.

(4.3) From company-specific research to aggregated results

The results from the aggregated research and the company-specific research are linked and confronted. Finally, an interface is built which helps to design and evaluate nation-wide policies starting from individual choice behaviour.

3.2. The results of the UFSIA research team

In this section, we discuss the conclusions of the literature review, the analysis of transport statistics and the results of modelling the mode choice in freight transport.

(1) Literature review

Drawing on the literature review, we can formulate the following conclusions concerning the modelling of mode choice:

- Modelling is mainly based on the competition between separate modes (unimodal) and rarely based on competition between logistic chains.
- Little attention is given to intermediaries (e.g. forwarding agent).
- Only short links are considered (origin-destination of goods). We note that, within the previous Impulse Program 'Transport and Mobility' (module B2), the freight transport was studied only within Belgium.

- The transport decision is mainly considered as a decision separate from the production process.
- There is a concentration on shifts between modes, and not on shifts in time.
- The importance of the transport cost in the total production cost is not always clear.
- It is very difficult to collect correct information on the (generalised) cost of freight transport at the aggregated research level.

(2) The analysis of transport statistics

On the basis of a critical analysis of the transport statistics (with a special emphasis on origin-destination data), it was possible to draw conclusions related to the goals of the research group. The conclusions are presented in three categories: reliability, usefulness and specific conclusions in relation with the research of the mode choice.

Reliability:

- In the data material available there is an important distinction between economic origin (destination) of the goods on the one hand and transportation origin (destination) of the goods on the other hand. The economic link between origin and destination can be divided into different transportation links. The concept of logistic chain is here introduced.
- It is not easy to establish a correct relation between production data and transported tonnes (because of the units used).
- The transport data of road freight transport is collected on the level of NUTS-1 (Belgian regions or 'gewesten'), as far as the collection by foreign (non-Belgian) statistical institutions is concerned.
- The collection of road freight transport data is a puzzle. Every national institution of statistics in the European Union is collecting data that is related to vehicles registered in its own country.
- As far as inland navigation and rail transport is concerned, differences are noted between several providers of data.
- The shortages of the statistical material is confirmed by the SERV study (SERV, Statistische analyse van de goederenstromen aan de hinterlandzijde van de Vlaamse havens, 1999, p. 30).

Usefulness:

- The data is mainly collected on a yearly basis.
- The databanks yield only partial information. We only get a view on the transportation origin and destination. The databanks do not take account of the concept of the logistic chain (economic origin and destination).
- The databanks do not provide information about the decision taker in the logistic chain. It is important to know who can influence the choice of modes.
- It should be stressed that quoted unimodal transport could be a part of a large logistic chain.

Specific conclusions in relation to the research of the mode choice:

- The collection of detailed data (e.g. data on the level of districts) is a very intensive and time-consuming work.
- Prudence is advised when using the data for the explanation and prediction of competition between road, rail and inland navigation. In addition, some modes are not considered (e.g. short sea shipping, pipeline and aviation), in terms of that competition. Naive use of data has to be avoided: it is very important to interpret the data in a correct way.
- The importance of competition between logistic chains on the one hand and the aspect of time on the other hand has to be stressed.
- There is a lack of data containing the time aspect (with the exception of traffic counts).
- In the analysis of freight transport, one has to take into consideration the capacity of the network. This also means that passenger transport cannot be neglected in the analysis.
- Bottlenecks are not only a matter of road transport. We can also see bottlenecks in rail transport (e.g. at Zeebrugge and Antwerp).

(3) Modelling the mode choice in freight transport

To understand the mode choice in freight transport, the UFSIA research group started from an aggregated approach. This means that the freight flows between zones were studied. Zones were here defined as Belgian districts (‘arrondissementen’). The research results from the previous Impulse Programme Transport and Mobility were used and re-evaluated. The explaining variables of mode choice were the price of transport, distance and gross domestic product. An econometric analysis was made to explain the mode choice in a quantitative manner. A problem with the analysis was getting accurate information about prices and tariffs. Contrary to the situation for passenger transport, it is very difficult to find the correct prices for freight transport. Indeed, there are important differences between real (applied) tariffs and officially published tariffs.

Results of the analysis can be found in:

- De Brabander, G., Meersman, H., Gentil, G., Pauwels T. en E. Van de Voorde, Eindverslag (Voortgangsverslag nr. 5). Module B2: Ontwikkeling Modules "Generatie" en "Modal Split" voor goederenverkeer voor Multimodaal Interregionaal Model (MIM): BijlageI: Korte bespreking van de empirische resultaten betreffende de modale uitsplitsing, UFSIA-SESO, Antwerpen, December 1995;
- Van de Voorde, E., Winkelmans, W. (et al), Aspecten van havencompetitiviteit, Finaal onderzoeksrapport (GOA 1995-1998), p. 169-174: estimation results of 3 mode relations and bimodal situations (road/inland navigation);
- Meersman en Van de Voorde: forthcoming paper on mode choice in freight transport.

On the basis of the aggregated research, the research group became convinced that it was necessary to perform additional, company-specific research in order to formulate relevant and conclusive recommendations. When studying the mode choice from a company-specific view, other explaining factors will play an important role. This will be particularly true for specific behavioural factors.

The company-specific research can be summarised as follows. First of all, an out-of-pocket cost function is constructed for the transportation of goods from an origin to a destination (by rail, road or inland navigation, inclusive combinations). In this way, it is possible to calculate the cheapest way to transport goods. In this stage the other logistic costs are considered as given. This cost function is evaluated in its ability to explain (understand) the mode choice. Second, the out of pocket cost function is generalised. This means that qualitative factors are quantified and put into the original cost function (e.g. quantification of the quality of service). Third, the obtained results are confronted with the actual decisions by means of case-studies and/or experiments (in which the interviewee has to choose among alternatives). Finally, the results from the aggregated approach and the company-specific research are linked and confronted.

4. Conclusions and recommendations

Using the research results and the experience of the project, future research will be focused on (among others):

a) Elaborating the cost functions

The cost functions as mentioned in 'Modelling the mode choice in freight transport' will be elaborated. It will be possible to determine the optimal choice between several types of transport. One of the extensions encloses the incorporation of qualitative factors and the construction of cost

functions based on combined transport. If the financial means are available, the proposed case-studies will be carried out. We have to take into account this is a time-consuming option.

b) Establishing a link to existing, foreign models

Existing (foreign) models on mode choice in freight transport are being analysed in detail. If possible, these models will be constructed for the Belgian situation. For example, the model MOBILEC describes the relationship between the economy, mobility, infrastructure and other regional features (van de Vooren, 1998). At this moment, the model exists and is running for the Netherlands. Based on the data collection (as mentioned in 'The analysis of transport statistics'), it is possible to construct the model MOBILEC for Belgium.

5. Annexes

5.1. Presentation of the UFSIA research team

The UFSIA research team belongs to the Department of Transport and Regional Economics of the UFSIA/RUCA Faculty of Applied Economics. The Department has always aimed at top level research. In its field, this means an efficient use of scientifically grounded specialist knowledge on the one hand, and practical and business knowledge on the other. The major topics of research in which the Department specialises are in the areas of freight transport, maritime and port economics, welfare economics and evaluation of transportation investment, location theory, spatial and urban governance, optimal planning and pricing of road freight transport, tourism and regional development.

For the building of scientific knowledge the Department can partly rely upon university funds, which are used mainly for the training and education of PhD-students. It also attracts external funds for financing research of the following types:

- research tasks for diverse contractors (e.g. the European Union, the World Bank, the Belgian federal government, the Flemish government, the Dutch government and others);
- limited tasks aimed at immediate application;
- larger projects of fundamental research.

Practical knowledge is mostly related to planning advice, consulting and individual research of Department members. In addition, some consulting work for companies has been done, applying the scientific knowledge to specific policy questions of private and public companies.

The Department is present in the national and international academic and research world. Its members publish in international journals and with a number of the most important international publishers (a.o. Pergamon Press, Lloyd's of London Press, John Wiley, Chapman and Hall, Elsevier, Ashlord,....) Department members present their work and are often asked as keynote speakers at international conferences and conventions. A number of them are regularly invited as visiting professors at universities abroad (Bari, Lisbon, Rotterdam,...)

The realisations of the last few years include:

- the publication of the Transportation Economics manual, which is not only unique within the Dutch-speaking area, but which is also progressive through its integration of many different points of view: industrial economics, logistics, macro-economics and transportation policy;
- the organisation of the World Conference on Transportation Research (WCTR) in 1998 (in co-operation with RUCA), probably the largest conference ever organised in the Antwerp Area;
- the launch of the Institute of Transport and Maritime Management Antwerp (ITMMA) together with RUCA and UIA, a successful initiative where an international group of students participates in highly ranked courses;
- the publication of three manuals in a series of cultural studies hosted by the Flemish Community;
- significant research in mobility management and urban governance.

For its future research management, the Department attaches great importance to continuity within the qualitative research efforts in each of its fields.

This research project gives the Department the opportunity to deepen and expand its knowledge and understanding of the freight transport market, its relation to the infrastructure and its interaction with economic activity. This strengthens the position of the Department in the international research environment. By incorporating the results and the research methodology into their teaching programmes, it will enable the Faculty of Economics to continue to give a high standard and up-to-date education.

5.2. Circulation and distribution of the results

- Meersman, H., Pauwels, T., Van de Voorde, E. en A. Verhetsel, Mode choice in freight transport: a link between aggregated and disaggregated research, paper to be presented at 9th World Conference On Transport Research (Seoul, South Korea), 2001, 11p.
- Pauwels, T., A method to compare origin-destination matrices of freight flows. The case of Belgium, paper to be presented at 9th World Conference On Transport Research (Seoul, South Korea), 2001, 10p.

- Heaver, T., Meersman, H. en E. Van de Voorde, Co-operation and competion in international container transport: strategies for ports, Research paper-Faculty of Applied Economics UFSIA-RUCA, 2001.
- Blauwens, G., De Baere, P. en E. Van de Voorde, Vervoerseconomie, Standaard, Antwerpen, 2001, 555p.
- Pauwels, T., Het goederenvervoer in België. Een kritische analyse van de transportstatistieken, met een specifieke aandacht voor herkomst-bestemmingsdata, UFSIA, Faculteit Toegepaste Economische Wetenschappen, Vakgroep Transport en Ruimte, Onderzoeksrapport 2000-04, March 2000, 71p.
- Van de Voorde, E., Winkelmans, W. (et al), Aspecten van havencompetitiviteit, Finaal onderzoeksrapport (GOA 1995-1998), blz. 169-174, 2000.
- Blauwens, G., Dullaert, W., Pauwels, T., Vanelslander, T. en F. Witlox, Ijzeren Rijn en Betuweroute: syntheseverslag van de paneldiscussie. In: Ijzeren Rijn en de Betuweroute: het debat op de juiste sporen?, Witlox Frank (edit.), Leuven, Garant, 2000, p. 157-160.
- Van de Voorde Eddy, Witlox Frank. - De IJzeren Rijn, economisch bekeken. - In: De IJzeren Rijn en de Betuweroute: het debat op de juiste sporen / Witlox Frank [edit.], Leuven, Garant, 2000, p. 93-116.
- Meersman Hilde. - Spoorvervoer en havens: enkele bedenkingen. - In: De IJzeren Rijn en de Betuweroute: het debat op de juiste sporen? / Witlox Frank [edit.], Leuven, Garant, 2000, p. 117-118.
- Meersman H., Van de Voorde E.. - Is freight transport growth inevitable ? - In: Which changes for transport in the next century? / European Conference of Ministers of Transport [edit.], Paris, OECD, 1999, p. 23-48.
- VERHETSEL A.(1999), A Multimodal model for traffic and transport in Flanders (Antwerp) : Sensitivity to different policies, with special attention for financial and regulatory measures; in VAN DE VOORDE E., MEERSMAN H. en WINKELMANS W. (eds), Selected Proceedings of the 8th World Conference in Transport research, volume II: Planning, Operation, Management and Control, Oxford, Pergamon, pp. 29-42.
- Meersman, H., Pauwels, T. en E. Van de Voorde, Bouwen aan een duurzame mobiliteit, Tijdschrift Vervoerswetenschap, vol. 34 (4, December 1998), p. 361-378.
- Pauwels, T., Modale keuze en modale uitsplitsing in het goederenvervoer: een literatuurstudie, October 98, 45pp., SESO-report 98/365.
- Pauwels T., Aspecten van de vraag naar goederenvervoer: modale keuze en modale uitsplitsing, October 98, 74pp., SESO-report 98/364.
- Van de Voorde Eddy, Meersman Hilde. - Minder overheid in het vrachtvervoer: de sector van het vrachtvervoer is een belangrijke testcase voor de deregulering: toch zal de overheid steeds een woordje blijven meespreken. - In: Trends review, (1998), p. 14-17.
- Meersman Hilde, Van de Voorde Eddy. - The effect of economic growth on future freight transport. - In: Which changes for transport in the next century? 14th International Symposium on Theory and Practice in Transport Economics, Innsbruck - 21/23 October 1997: topic 1: what is the future for transport?, Paris, CEMT, 1997, 36 p.
- Meersman Hilde, Van de Voorde Eddy. - Future strategies for rail freight: taking advantage of the transport generating effects of seaports. - In: Rail international, 9/10(1997), p. 206-215.
- Meersman H., Van de Voorde E.. - Prognoses van de vraag naar goederenvervoer: cijfers bij economische groei, modale keuze en vervoerbeleid. - In: Energie en milieu, 12:3(1996), p. 131-136.
- Blauwens Gust, De Baere Peter, Van de Voorde Eddy. - Vervoerseconomie. - Deurne : MIM, 1996. - 480 p. - (Universitaire reeks economie ; 1996:1). - ISBN 90-341-0834-1.
- Van de Voorde Eddy. - Vervoerseconomisch doorgelicht? Kostenfuncties en industriële structuur in het vrachtvervoer. - In: Economisch en sociaal tijdschrift, 50:3(1996), p. 379-401.
- Jorissen Ann, Meersman Hilde, Van de Voorde Eddy, [et al.]. - De Nederlandse goederenvervoermodellen. - Rotterdam : Ministerie van Verkeer en Waterstaat, 1991. - 158 p.

- Van de Voorde E., Meersman H.. - De vraag naar personen- en goederenvervoer. - In: Verkeer in België in 2000: twintigste Vlaams Wetenschappelijk Economisch Congres, Gent 17-18 October 1991, Gent, RUG, 1991, p. 3-63.
- 1990-1995: interim reports and end reports (Impuls Programme Transport and Mobility), user: DWTC.
- December 1997, June 1998, December 1998, June 1999, December 1999, June 2000, December 2000: activity reports (Programme Sustainable Mobility), user: DWTC.