TRANSPORT, COMMUNICATION AND MOBILITY RESEARCH
IN THE NETHERLANDS: A SURVEY

ONDERZOEKSIINSTITUUT VOOR
TECHNISCHE BESTUURSKUNDE
BIBLIOTHEEK
Thijsseweg 11 2629 JA Delft

ISBN 90-6275-457-0
TRANSPORT, COMMUNICATION AND MOBILITY RESEARCH
IN THE NETHERLANDS: A SURVEY

Editors: G.R.M. Jansen
C.J. Ruijgrok
P.H.L. Bovy
H.J. Noortman

Research Institute of Urban Planning and Architecture (O.S.P.A.)
Department of Architecture
Delft University of Technology

Delft University Press
CONTENTS

Preface
Summary

Samenvatting

1. GENERAL ORIENTATION .................................. 5
   1.1 The Netherlands: a short characteristic ................ 11
   1.2 Some general developments ............................ 12
   1.3 Some current policy issues ........................... 12
   1.4 TCM-Research: a general outline ...................... 13
   1.5 Organization and financing of TCM-research .......... 14
   1.6 Publications ........................................ 15
   1.7 International contacts ................................ 15
   1.8 Data .................................................. 16

2. SOCIO-ECONOMIC CONTEXT ANALYSIS .................. 17
   2.1 Introduction .......................................... 17
   2.2 Trends in the socio-economic context ................. 17
      2.2.1 Demographic trends ............................... 17
      2.2.2 Socio-economic trends ............................ 18
      2.2.3 Economic trends .................................. 18
      2.2.4 Geographical trends ................................ 19
   2.3 Important research issues .................................. 19
   2.4 Gaps in knowledge ....................................... 20
   2.5 Emerging research directions ........................... 21
   2.6 Theoretical developments and analytical tools ........... 21

3. TECHNOLOGICAL CONTEXT ANALYSIS ................ 23
   3.0 Introduction ........................................... 23
   3.1 Important trends ........................................ 23
   3.2 Research issues ......................................... 25
   3.3 Gaps in knowledge ...................................... 27
   3.4 Emerging research directions ............................ 27
   3.5 Theoretical Developments ................................ 28

4. BEHAVIOURAL ANALYSIS ............................... 29
   4.1 Trends in behavioural patterns ......................... 29
      4.1.1 Transportation ...................................... 29
      4.1.2 Communication ...................................... 30
      4.1.3 Mobility and location ............................... 30
   4.2 Research issues in behavioural research ............. 31
      4.2.1 Transportation ...................................... 31
      4.2.2 Communication ...................................... 33
      4.2.3 Mobility and location ............................... 33
   4.3 Gaps in behavioural knowledge ......................... 33
      4.3.1 Transportation ...................................... 33
      4.3.2 Communication ...................................... 35
      4.3.3 Location and mobility ............................... 35
   4.4 Emerging research directions ........................... 35
4.4.1 Transportation ........................................ 35
4.4.2 Communication ...................................... 36
4.4.3 Location and mobility ................................. 37
4.5 Theoretical developments ............................... 37
  4.5.1 Transportation ...................................... 37
  4.5.2 Location and mobility ............................... 38
4.6 Analytical tools in transportation research ............ 38

5. POLICY ANALYSIS ........................................ 41
  5.0 Introduction ........................................... 41
  5.1 Megatrends ............................................. 41
  5.2 Research issues ........................................ 43
  5.3 Gaps in knowledge ..................................... 44
  5.4 Emerging research directions ......................... 44
  5.5 Theoretical developments ............................. 45
  5.6 Analytical tools ....................................... 45

6. PROSPECTS ................................................. 47

Appendix-1: Theme report socio-economic context analysis
Appendix-2: Theme report technological context analysis
Appendix-3: Theme report behavioural analysis
Appendix-4: Theme report policy analysis
Appendix-5: List of respondents
Appendix-6: Some publications on Dutch TCM-research
Preface

In 1986 the European Science Foundation, headquartered in Strasbourg, started the scientific network on Transport, Communications and Mobility. The purpose of such a network is to promote scientific cooperation in Europe with a focus on collaborative basic science activities. The international coordinating team of this network decided to provide a representative and coherent state-of-the-art view on national know-how during the first phase of the network. This overview was to be limited to an number of fields of the broader TCM-area. The longer-term objective of the network is to start cross-national collaborative research projects in the second phase. The overview should help in formulating research proposals.

For this reason a cross-national comparative survey was held. In every country a national team was established with its main task to write a national report on the basis of the outcomes of a questionnaire survey. The international committee designed the questionnaire and also gave strict rules as to the structure of the national report.

To avoid the anticipated low response to the proposed questionnaire survey, the Dutch team decided to write the national report in draft first and then to ask respondents for their comments. They could give their comment in writing and further a meeting was held to discuss the draft report. Then, the report was amended accordingly.

The Dutch team considers it a useful idea to publish the Dutch national report as an independent publication. It gives a rather broad review of research trends and fruitful areas for future research. It might be a help to all those agencies and individuals which have the difficult task of formulating research programs in the TCM-field. A summary of the Dutch review will be included in the publication on the European state-of-the-art of TCM-research that is planned.

Finally, we want to thank our Dutch colleagues who were prepared to give their invaluable comments to earlier drafts of this report. The division of tasks in the Dutch was as follows:

national coordinator: G.R.M. Jansen

theme coordinators:
socio-economic context
analysis
: G.R.M. Jansen, Delft University of Technology

technological context
analysis
: C.J. Ruigrok, Free University, Amsterdam

behavioural analysis
: P.H.L. Bovy, Delft, University of Technology

policy analysis
: H.J. Noortman, University of Amsterdam

Delft, januari 1988

The editors
Summary

In 1986 the European Science Foundation, headquartered in Strasbourg, started the scientific Network on Transport, Communications and Mobility. The purpose of such a network is to promote scientific cooperation in Europe with a focus on collaborative basic science activities. It was decided to provide a representative and coherent state-of-the-art view on national know-how during the first phase of the network. This overview was to be limited to a number of fields of the broader TCM area. The overview should help in formulating proposals for cross-national collaborative research projects. For this reason a cross-national comparative survey was held.

This report describes the results of the survey with respect to research on transport, communications and mobility in the Netherlands. Its structure conforms to the guidelines and specifications imposed to all national reports.

Four themes have been dealt with: socio-economic context of TCM, technological context, TCM behaviour and TCM policy. For each of these themes the following aspects have been surveyed: major trends, important research issues, gaps in knowledge, emerging research directions, theoretical developments and analytical tools. The final chapter gives some prospects for future cross-national collaborative research.

The main text of this report presents the results of the survey in a condensed manner. More detailed information on each theme can be found in the appendices.
Samenvatting:

"Onderzoek op het gebied van transport, communicatie en mobiliteit in Nederland: een overzicht".

In 1986 heeft de European Science Foundation, met zetel in Straatsburg, het wetenschappelijke netwerk op het gebied van Transport, Communicatie en Mobiliteit geïnitieerd. Het doel van een dergelijk netwerk is de wetenschappelijke samenwerking in Europa te bevorderen met het accent op gezamenlijke fundamentele wetenschappelijke activiteiten. Besloten werd in de eerste fase van dit netwerk te starten met het vervaardigen van een representatief en samenhangend overzicht van nationale kennis. Dit overzicht bestrijkt een beperkt aantal velden van het brede terrein dat boven is aangeduid. Het overzicht maakt het formuleren van voorstellen voor internationale samenwerkingsprojecten van onderzoek beter mogelijk. Een internationaal vergelijkend onderzoek werd met dat doel gehouden.

Dit rapport bevat de uitkomsten van dit onderzoek voor wat betreft de Nederlandse situatie. De opbouw volgt de richtlijnen en specificaties die voor alle nationale rapportages waren afgesproken.

Vier thema’s zijn onderzocht: sociaal-economische context van transport, communicatie en mobiliteit (TCM), technologische context van TCM, TCM-gedrag en TCM-beleid. Voor elk van de vier thema’s zijn de volgende aspecten bestudeerd: voornaamste ontwikkelingen, belangrijke onderzoeksthema’s, lacunes in de kennis, opkomende onderzoeksrichtingen, theoretische ontwikkelingen en analytische instrumenten. Het laatste hoofdstuk behandelt de mogelijkheden voor toekomstige internationale onderzoeksprojecten.

Het rapport zelf beschrijft de uitkomsten van dit overzicht op een beknopte wijze. Meer gedetailleerde informatie met betrekking tot elk van de vier thema’s is te vinden in de bijlagen.
1. GENERAL ORIENTATION

1.1. The Netherlands: a short characteristic

In a geographical sense, The Netherlands has a number of marked properties. It is a small country with a land area of ca. 33,000 sqkm, situated at the North Sea and surrounded by three big nations: Federal Republic of Germany, Great Britain and France. It is criss-crossed by large rivers flowing into the sea. Having a population of nearly 15 million, it is the most densely populated country of Europe; population density amounts to 428 inhabitants per sqkm. The Netherlands can be regarded as an entirely urbanized country without rural areas in a classical sense. About 75% of the population lives in cities of 20,000 inhabitants or more. The so-called Randstad is a ring-shaped conglomeration of contiguous cities in the western part of the country, having a total population of about 6 million. Amsterdam, Rotterdam and The Hague are part of it. In the neighbouring countries, large population concentrations can be found at short distance of The Netherlands, e.g. the Ruhr-area, the Belgian tri-city triangle and the London metropolitan area.

Economically, The Netherlands is a post-industrial society with a highly developed agricultural ('agro-business') and service sector which includes a strong transport sector. A notable characteristic of the Dutch industry is the relatively large number of big Dutch multinationals, e.g. Royal Dutch Shell, Unilever, Philips, Akzo. They determine the industrial landscape to a large extent. Despite current serious economic problems, The Netherlands is one of the rich European countries. Together with Belgium it is has the most open economy of Europe.

Regarding Dutch infrastructure, the important role of sea transport and inland waterways should be recognized, which stems from its geography. Its location at the North Sea and the Rhine in the middle of a highly industrialized hinterland was crucial to the development of Rotterdam to the biggest port of the world. Massive goods transport takes place by ship on an excellent system of rivers and canals within the country and to Germany and Belgium.

A dense network of high-quality motorways connects all parts of the country and is linked up with similar networks in the neighbouring countries. In particular in the Randstad and the southern part of the country, this network is loaded to its capacity resulting in serious daily congestion.

The railway network connects all large and medium-sized cities with a minimal frequency of one train per half hour. In the Randstad area, this network functions like a metropolitan system with many stations at short distances and intercity train frequencies of 10 to 15 minutes. In this part, network capacity is fully used.

Total yearly Dutch personal mobility amounts to ca. 150 thou-
sand million person kilometers of which 90% is travelled using private means of transport. The lion's share of about 80% is accounted for by the car. Compared to other countries the bicycle mode has a significant share of 9%. All public transport modes together serve about 10% of the total distance travelled.

Car ownership is currently 340 cars per thousand inhabitants, whereas personal bicycle ownership is extremely high with ca 800 per 1000 inhabitants. In this latter respect The Netherlands is different from most European countries.

1.2 Some general developments

In this section a number of important developments having an effect upon the TCM-field will be discussed. Emphasis is put on trends that are typical for The Netherlands. First of all the Dutch population has been growing at a relatively high rate during the recent decades. In this respect it is different from most surrounding countries. Although birth rates decreased rapidly since 1970, an important consequence is the current and expected large growth of the work force.

Another typically Dutch characteristic is the rapid growth of the number of married women that are employed or looking for a job. Traditionally, the share of married woman that are employed is very small in this country compared to other European countries. Therefore, this rapid growth can be regarded as catching up with more general patterns.

The increasing integration of the Netherlands in the European Community has large impacts on the TCM-field. On the one hand these consequences are related to traffic flows, especially with respect to business travel and to goods transport. On the other hand, this European integration leads to an increasing role of Community transport policies and legislation.

Currently, governmental policy is very restrictive towards investing in large infrastructural projects. The main reason is the commitment to cut the budgetary deficit, although in case of road networks environmental considerations also play also a role. Present transport policies strongly encourage better use of existing facilities, although further possibilities to do this will disappear in the near future. Recently, private financing of infrastructural investments is being discussed.

1.3 Some current policy issues

In this section some policy issues in the Dutch TCM-field are mentioned briefly:

- Congestion and lack of capacity
  The motorway system in the Randstad area is suffering from serious congestion, in particular in the periphery of the
large cities. In order to enhance further economic development of these urban areas and in particular to promote the distributional functions of the large Dutch sea harbours and airports, several policy options are under investigation to relieve these capacity problems.

- Deficit reduction public transport
  Although recent policy measures succeeded in halting the explosive growth of public transport deficits, the subsidy level is still a cause for concern. An important policy issue is therefore how to reduce this level and at the same time preserve the social role of public transport and its function from a planning point of view.

- Urban deconcentration and inner cities
  In regional planning the choice of the locations of residential and work areas to developed is a major strategic issue. This is true in particular for the urban areas in the Randstad. Important considerations refer to the objective to concentrate activities as much as possible in the urban areas and to revitalize the inner cities.

- Enhancement distributional function
  The Netherlands can be regarded as the Northern Europe's distributive hub. A major transport policy objective is to enhance this function still further and to adapt it to new developments in the economic and geographic context. This is achieved by an adequate policy with respect to sea ports, airports and the transport sector in general.

- Environmental problems
  After a decade in which noise pollution and energy consumption were the main environmental problems related to traffic, now the central environmental issue is to control traffic air pollution (acid rain).

- High speed train connections
  A major decision to be made in the near future is whether to build high speed rail lines to The Netherlands. The construction of the Channel Tunnel and the shift of Europe's economic centre towards the south, may cause The Netherlands to be situated gradually at the periphery of Europe's economic heartland. One of the means to prevent such a peripheral position is to extend high speed rail lines from Paris and Germany to The Netherlands.

- Construction of a broadband telecommunication network
  In the field of telecommunication the design and construction of a broad-band telecommunication network is an important policy issue.

1.4. TCM-Research: a general outline

It is difficult to draw a line between research and consultancy in the field of TCM in The Netherlands, because in this country
many policy-oriented studies have a significant research component. It may be argued that the Netherlands has a well-developed, modern and innovative research structure in the field of TCM, in particular so when considering its small size. The number of specialists carrying out TCM-research can be estimated at approximately 80 to 100. Noticeable is the stimulating role of the Departments of Transport and of Housing, Physical Planning and the Environment with respect to research on personal travel and regional planning. The professionals mentioned above are more or less evenly distributed among the universities, including the Netherlands Organization for Applied Scientific Research TNO, the consultancy firms and the departments. The operation of foreign consultants on the Dutch market, often in partnership with Dutch counterparts, results into an intensive international exchange of insights and knowledge.

1.5. Organization and financing of TCM-research

TCM-research is mainly carried out by the following institutions:

* Universities
  - Delft University of Technology
    Department of Civil Engineering - Transportation Engineering Section
    OSPA, Research Institute for Urban Planning and Architecture
  - University of Groningen
    Research Centre for Traffic Engineering
    Institute for Geography
  - Free University, Amsterdam, Department of Economics
  - University of Amsterdam, Department of Economics
  - Erasmus University, Rotterdam
  - University of Utrecht
* Netherlands Organization for Applied Scientific Research, TNO
  Institute of Spatial Organization
* Consultancies
  - Netherlands Economic Institute
  - Netherlands Institute of Transport
  - Buro Goudappel Coffeng
  - Hague Consulting Group
  - others
* Department of Transport and Public Works
  - Directorate General of Transport
  - Rijkswaterstaat - Transportation Engineering Division
  - Projectburo IVVS
* Department of Housing, Physical Planning and Environment
  - National Agency for Physical Planning

This list is not exhaustive.

There are two main sources from which TCM-research is financed. The first one are the universities which sponsor research programmes themselves that are carried out by university insti-
tutes. The second and at least equally important financial source are the above mentioned departments which commission numerous research projects to consultancies as well as university institutes. These departments have large units that coordinate and monitor the research projects commissioned to third parties. These units also carry out research in-house. In addition, smaller financial sources are the own resources of TNO, the subsidies of the Dutch Organization of Pure Research, funding by the European Community and contracts from local authorities and private firms.

An important network of TCM-researchers is the Colloquium Vervoersplanologisch Speurwerk (Transportation Planning Research Colloquium). Since 1974 this organisation yearly holds a two-day meeting attended by some 80 researchers. Participants are required to submit and present a paper which form the basis of the discussion. Emphasis is on transportation subjects, although regional planning themes are discussed too. Proceedings are published containing all papers with english summaries. In addition to these annual meetings CVS organizes so called seminars where foreign and Dutch speakers together discuss TCM research topics.

In the field of regional science and planning similar meetings, called Planologische Discussiedagen, are organized annually. The TCM-field is only a small part of this conference theme. In particular, transport is only a marginal subject. The meetings are usually attended by several hundreds of planners, geographers, etc., who do not have to submit a paper.

1.6. Publications

Research results are published in many ways. First of all there are research reports of the university institutes, departments, TNO and consultancies. Furthermore, publications are made in a number of Dutch journals like Verkeerskunde, Tijdschrift voor Economische en Sociale Geografie TESG, Stedebouw en Volkshuisvesting and Transportation.

A very useful source of information are the proceedings of the annual meetings of the Colloquium Vervoersplanologisch Speurwerk. Many publications of Dutch TCM-research can be found in the proceedings of the PTRC-Summer Annual Meetings.

1.7. International contacts

As was mentioned above the Dutch professional community has frequent and intensive international contacts. These contacts refer to:
- cooperation with foreign consultants;
- presentation of research results at international conferences, in particular at meetings of PTRC, Transportation Research Board, World Conference of Transport Research, International Conference on Travel Behavior and the Regional Science Association.
participation in various committees of OECD, CEMT and COST.

1.8. Data

The Central Bureau of Statistics collects numerous statistics with respect to the infrastructure, means of transport, mobility and the production of the transport sector since many decades. It is interesting to mention two special surveys that facilitate transport research a great deal in The Netherlands. These rather unique data sources are:

1. National Mobility Survey
   Since 1978 a household survey is held yearly among about 8000 households with respect to their personal travel on two consecutive days. Members of the households are asked to fill in a trip diary. This survey enables a monitoring of Dutch personal mobility. Time series and other analyses of travel patterns and travel behaviour can easily be made.

2. Dutch National Mobility Panel
   In addition to the above mentioned survey, which is essentially a repeated cross-section measurement, the Ministry of Transport holds a so-called panel survey since 1984. Some 2000 households are interviewed each half year with respect to their travel pattern during a complete week. Since in principle the same individuals are interviewed repeatedly, longitudinal analyses of individual travel behaviour can be made. Methodological problems with this kind of analysis should not be underestimated, however.
2. SOCIO-ECONOMIC CONTEXT ANALYSIS

2.1 Introduction

In the framework of this survey socio-economic context is defined as the demographic, social and economic aspects of society that affect the TCM-pattern. For pragmatic reasons geographic aspects will be dealt with in this theme although they easily could be seen as the result of certain mobility decisions.

In accordance with the general set-up of this survey only the effect of the socio-economic context upon the TCM-pattern is discussed. The reverse relationship dealing with the effect of TCM upon the socio-economic aspects of society, is not treated here. Little research has been carried out on this latter subject in this country, anyhow. It has been tried to treat transport, mobility and telecommunication in equal detail in this survey. Given the amount of research on these three themes in The Netherlands it not surprising that personal travel will be the main item.

2.2 Trends in the socio-economic context

2.2.1 Demographic trends

A major demographic trend in the last two decades is the large decrease in population growth: the annual rate of increase fell from 1.3% in 1965 to 0.4% in 1985. This rate is expected to decrease slowly in the near future.

The main cause of this change is the marked and rapid reduction of the birth rate since 1965. Not only population growth slowed down, also a marked shift in the age distribution can be noticed. The number of young people fell sharply and at the same time the age group 20-64 increased significantly, due to the high birth rates of twenty to forty years ago. This trend is expected to continue in the coming decades. It may be expected that these changes have affected and will further affect the travel patterns. Research showed that both these demographic trends will result in an increase in car travel and in a reduction in bicycle and public transport use. In particular, travel to and from work will grow, whereas travel with educational purposes will decrease significantly. These are purely demographic effects.

A third main demographic trend is the reduction of the average household size, due to both the smaller number of children and to changing lifestyles. This change affected the demand for housing, population densities and travel patterns.
2.2.2 Socio-economic trends

In this section four aspects will be discussed: income, labour participation, car ownership and flexibility. In The Netherlands the deep economic recession of 1982-1984 caused a sharp reduction in the growth of net incomes. Real incomes increased annually by ca. 5% prior to 1975, whereas the average annual decrease was ca. 2% between 1979 and 1984. Research indicates that an income rise results in a general increase of travel. Income elasticity is highest for car travel. It is therefore likely that the observed stagnation in mobility trends in the early eighties stems from a lack of income growth.

With respect to the labour force a number of simultaneous changes occurred in The Netherlands. The first one is the rapid growth of unemployment between 1980 and 1985; unemployment is higher than in most other countries, predominantly because of a larger number of people looking for a job, e.g. school-leavers, married women.

A second marked trend is the large increase in the number of employed married women. The proportion of married women having a job or looking for a job rose from 7% in 1961 to 33% in 1981. Since this share is still significantly lower than in most other European countries, The Netherlands is catching up in this respect. Finally, partly in connection with this change the number of part-time jobs is increasing rapidly. Most of these jobs are occupied by married women. It is clear that changes in job participation and employment affect travel patterns and vehicle ownership, partly through income effects.

Car ownership increased sharply during the last two decades from 104 cars per 1000 inhabitants in 1965 to 340 in 1985. Clearly due to the economic crisis the growth rate of car ownership was significantly lower in the period of 1975-1984 than in the prior period. The rise in car ownership is a major cause of the large increase in mobility.

The last trend to be mentioned here is the increase in flexibility and differentiation in the societal organization. Important aspects are the multitude of household types, less rigid and fixed working times, flexible pensioning ages, more individual educational programmes, individual holiday schemes, etc. This phenomenon will affect activity schedules and through that travel patterns.

2.2.3 Economic trends

Two economic trends will be briefly discussed here. They both deal with the organization of the production. The first development is the so-called dematerialization of the economy: in the Dutch industrial sector a shift is going on towards the production of low-weight-high-value products. This means that per unit of national product a decreasing weight of commodities is used. Statistics indeed show a more or less constant volume
of goods transported since 1978. The shift towards high-value products together with newly developed logistical management procedures, leads to an increased use of the truck in freight transport.

Another important trend is the globalisation or internationalization of the economy, leading to growing commodity flows between The Netherlands and other European countries as well as with the USA and South-East Asia. The share of the truck in international freight transport is increasing because of the type of products transported and the logistical context transport takes place in. As a result international truck transport is growing quickly.

2.2.4 Geographical trends

It was decided to treat geographical trends here, although they are partly the consequence of mobility decisions and as such part of the object rather than of the TCM-context. Suburbanization of the population and to a lesser extent of urban employment is an important development of the last two decades. Between 1970 and 1985 the four Dutch big cities lost approximately 20% of their population to the suburban areas. This outward shift of about 0.5 million residents had enormous consequences for the metropolitan travel patterns. Given that this suburbanization was enabled by the motorization, it is not surprising that large car traffic volumes to and from urban areas were induced.

Large volumes of commuters were the result of the suburbanization. However, other factors also contributed to the growth of the number of interurban commuters like differentiation of the labour market, car ownership, higher income, regional and housing policies.

2.3 Important research issues

A number of serious policy problems resulted into TCM-research in The Netherlands during the last two decades:
- widespread congestion on the motorway system in the Randstad;
- large and rapidly growing deficits in public transport;
- environmental effects of car traffic;
- deterioration of the favourable conditions for cycling and walking in cities.

Important research issues of the recent past are:

a. Spatial activity patterns and travel.
Relocation of households and firms has affected travel patterns to a large extent. Therefore a lot of research has been carried out in the seventies in order to gain understanding of the interdependence of travel patterns and moving and locational behaviour. Behavioural studies
are reported in chapter 4. Attempts to model these interrelationships in a simultaneous way using Lowry-type models were not successful.

Later the Netherlands Economic Institute analysed the dynamic relationship between household migration, job change and home-to-work travel in great detail.

More recently a more pragmatic approach was adopted to analyse the effect of spatial activity patterns on travel patterns in a unidirectional way: given alternative spatial distributions of population and employment the resulting traffic flows are calculated using sophisticated transport models. E.g./Zuidvleugel/study, /Bolt/study and the Strategic Study Randstad.

b. Car ownership analysis
Since car ownership analyses were mainly made at the individual level these are discussed in chapter 4.

c. Travel patterns and the economic situation
Since 1979 it became clear that the economic situation has a significant influence upon travel patterns. During the severe economic recession of 1982-1984 long term trends in traffic volumes were discontinued. Existing forecasts apparently were based on the implicit assumption that the economy would develop in a continuous way. A crucial research issue therefore became the relationship between the economic situation and transport, which was (and is) hardly understood. Studies were initiated on the effect of income decline on travel behaviour.

d. Employment status and travel
In this country an increasing proportion of married women is employed, the number of part-time jobs rises quickly, the regular working week is becoming shorter and the number of unemployed is high. It is not clear how these developments affect travel patterns. Partially, these consequences were investigated. For instance, Delft University of Technology analysed the effect of job status by comparing mobility of various classes of households, having different numbers of workers. The effect of shortening the regular working week on peak period travel has been studied using simulation.

2.4 Gaps in knowledge
Generally, the feeling is that even after twenty years of rather extensive research into TCM, in fact the understanding of the impacts of the socio-economic context on travel and transport is still limited. Moreover circumstances seem to change more rapidly than research can provide well-founded insights into their effects. In fact, a lot of gaps in existing knowledge of the effects of the socio-economic context could be mentioned. Three will be discussed here:
1. Goods transport
Compared to personal travel even less is known about the effects of the economic context on goods transport. This holds mainly at the regional and urban level. The changing economic structure cause a shift in commodity flows and lead to new requirements to the infrastructure. Understanding of these relationships is limited, especially with respect to shippers’ behaviour.

2. Business travel
In view of the revised priorities in transport policy in favour of commercial transport, it became clear that very little is known about the nature and background of business travel. If transport policy intends to take special measures for business travel, more needs to be known about the relationship between the (socio)-economic structure and this type of travel.

3. Special socio-economic changes and personal travel
Demographic changes and changes in lifestyle will affect personal travel to a large extent. In particular changing age distribution, job participation and because of that income changes will affect personal travel in a complex and still unknown way.

2.5 Emerging research directions
In this section a few research directions that came up in the recent past will be discussed. They deal with new problems related to the socio-economic context of TCM.

a. The effect of industrial activity on transport and telecommunication
In order to investigate the effects of a changing industrial production organization research is being started into the complex relationship between production, logistics, telecommunication, freight transport and firm location choices. Shippers’ behaviour is an important aspect of this research, (see also chapter 4).

b. The effects of prices on travel
This research direction will be discussed in chapter 4.

c. The effect of specific socio-economic changes on travel
This item has been discussed in the previous section.

2.6 Theoretical developments and analytical tools
In the framework of the socio-economic context analysis only theories that deal with the impacts of socio-economic factors on TCM-patterns are relevant. Most of the theories that are used in such analyses refer to either socio-economic phenomena or to travel and mobility behaviour. The latter ones are exten-
sively dealt with in chapter 4. Here, only two theoretical developments are mentioned:

a. Theory of human activities
   Since personal travel is derived from the activities individuals perform, travel impacts of changes in socio-economic characteristics could be explained using theories of human activity patterns. Some work has been done with respect to the scheduling of activities of household members given constraints on vehicle availability, shopping and working hours as well as the need for coordination between members. See also chapter 4.

b. Urban dynamics
   Although theories on urban processes encompass many more factors than socio-economic aspects, they will be touched upon briefly. Interesting theoretical advances were achieved at the Netherlands Economic Institute and at the Free University of Amsterdam. A general theory on urban development was formulated, with a relationship between economic and urban processes as a starting point. Furthermore, the dynamics of household relocation, job change and commuting has been studied intensively, resulting in an extensive theoretical body.

Analytical tools that were used in analysing the effects of socio-economic context changes were – apart from the wide range of aggregate and disaggregate models – the following:

a. Cross-section and time series analyses
   Many effects of socio-economic variables have been studied using cross-sectional data referring to one point in time. A main data source for this kind of analysis is the National Travel Survey which is held annually. (see section 1.8). Households or individuals are segmented according to their socio-economic characteristics of interest and travel behaviour is compared between classes. Repeated cross-section analyses (time series) have been carried out using the same data source.

b. Panel survey analysis
   A major innovation in The Netherlands is the Dutch Mobility Panel (see section 1.8). This unique data enable longitudinal analyses of individual travel behaviour to be made. Special analysis techniques were developed in order to carry out such longitudinal studies. (see also chapter 4.)

c. Quick response techniques
   A growing need among policy makers exist for models that are able to make aggregate travel predictions within a short response time. An excellent example of such a quick-response model is the so-called 'Mobility Explorer', developed by TNO-INRO. With this model it is possible to determine the effects of changes in population size, age distribution, income, employment etc. on the aggregate national travel.
3. TECHNOLOGICAL CONTEXT ANALYSIS

3.0 Introduction

Since the invention of the wheel transport and technology have developed in close harmony. The development in population growth, urbanization and economic activities have led to a permanent pressure to realize faster, more efficient and more reliable means of transport.

But also the reverse is true: through the fast developments in technology within and outside the transport sector the demand for transport and mobility in general has increased permanently.

Thus technological context analysis deals with two aspects: the investigation of the possibilities of the development of new technologies to satisfy the existing demand for transport on the one hand and the determination of possible consequences of new technologies on the other.

The development of new technologies often is no matter for individual firms or individual countries. Only through the combination of forces it is possible to create a positive return on investments for large-scale technological innovations. The Eureka project and the formation of multinational joint ventures reflect examples of such R&D initiatives.

The result of this is that technological developments and the technological context analysis of the TCM field hardly can be reviewed on a national scale. Developments in The Netherlands will resemble developments in other European countries considerably. An exception may be the way in which some of the negative external effects of mobility have been reduced by governmental policies (especially the reduction of traffic noise).

The treatment of the technological context in this chapter will primarily deal with technological change within the transport sector itself: the development of new transport technologies and the infrastructure required. Sometimes the boundaries of the transport system are difficult to determine. Only partially technological changes outside the TCM sector which have an impact on the transportation sector will be mentioned (developments in logistics for instance).

3.1 Important trends

In this section the trends that will be discussed have emerged in the last decade and will almost certainly continue in the next future. The most important ones are:

a. The increasing usage of information technology in the control and automation of transport. Examples are:
- The increased usage of information systems for a better control of transport processes. In freight transport this has led to improved tracking possibilities and improved techniques for electronic transmission of data (up till now especially in harbours and at customs). In passenger transport the development of monitoring systems in public transport (automatic registration of passengers entering and leaving buses) and the development of sophisticated traffic monitoring systems can be mentioned.

- The automation of activities that before were done by hand or through hand driven tools. The loading and unloading of trucks and vessels is increasingly done automatically using special technologies. Automatic traffic control is more and more responsive to actual traffic flows.

- The increased usage of means of telecommunication has led to the possibility of remote control of processes. On core units information from distant locations is brought together, processed and transmitted in order to control transport processes both in freight and passenger transport.

b. In the freight sector in particular the increased awareness of the importance of logistics and the logistical organization has had an important influence on the transport function. In integral logistics production and transport are considered as equally important to achieve the goals of a reliable and flexible logistical operation through all elements of the logistical chain. On the basis of integral cost calculations optimal configurations are chosen that are not necessarily identical to the result of partially optimised systems. As a result of this shippers and carriers are trying to increase their span of control and are forming organizational structures to increase the vertical integration.

For the TCM sector this has led to an increase in the amount of logistical data interchange and also to changes in the amount and the appearance of transport. The globalisation of production has led to increased transport quantities and the tendency towards flexibilisation and increased reliability has led to the increased usage of faster, smaller and more expensive means of transport. Technological solutions are sought for to increase the level of reliability (application of informatics and automation).

c. A third major trend which has emerged more recently partly as a consequence of the developments mentioned under b. is related to the increased attention for high quality infrastructure. The accessibility of economic centres is endangered by the increased mobility. The satisfaction of the demand for transport and the achievement of the required level of reliability can only be fulfilled through large investments in road and rail infrastructure in order to solve pre-
sent and expected bottlenecks. The discussion regarding 'Missing Links' by European industrialists and European networks for high speed trains indicate that these issues not only are topical in The Netherlands. Large-scale infrastructural projects ask for a re-evaluation of existing technologies. High speed trains ask for advanced technologies to overcome the problems of the non-standardised European railway networks or even completely new technologies (Maglev).

In designing new car infrastructure new technologies emerge to increase the level of safety and increase the capacity (Prometheus). In The Netherlands these developments are followed with great interest but have not yet led to large study projects regarding the economic feasibility of such new technological concepts.

d. A fourth major trend deals with the reduction of negative external effects of car traffic. Technological instruments in this area relate to:
- adaptation of vehicle construction and motor technology (mass reduction, rolling resistance, fuel substitution, exhaust reduction)
- changes in road conditions (speed limitation, ramp metering)
- affecting travel behaviour (information)

The major part of these instruments is aimed at improving the air quality through a reduction of the emission of toxic gasses. Another part is meant to reduce noise pollution, energy usage and production of waste materials). An important area of technological development is related to the improvement of traffic safety. Measures in this respect are crash protection and improved traffic control.

In the past decades an important part of the negative external effects of car traffic have been reduced. The present level of pollution and unsafety is by far not satisfactory and additional measures will be necessary in near future, also in anticipation to the expected rise in car mobility.

3.2 Research issues

The research issues that presently get or deserve attention are closely related to the trends mentioned in section 3.1. The consequences of the technological developments onto the TCM sector are not very well understood yet and a considerable research effort is necessary to get a better insight and to guarantee an adequate allocation of funds for these technologies. It is felt that research effort is especially necessary in the following areas:

a. Research regarding the effects of increased application of informatics on the future developments in freight and passenger transport. The demand and realization of transport flows. It is not certain whether the application of informatics will lead to a substitution or to a generation of traffic. Telematics, teleworking and teleshopping each seem to have possibilities to substitute physical trips or trans-
ports. However, the intensification of the communication possibilities will create a new demand by itself. Also in freight transport this tendency can be observed: the application of 'just-in-time' technologies leads to an increased number of messages to be exchanged between logistical partners. At the same time it leads to a reduction in shipment sizes and towards a shift in trade offs between transport and inventory costs, thus creating an increase in the number of shipments.

b. The consequences of the changing logistical organization on the infrastructural requirements and the transport equipment necessary requires further attention. Research in this area could regard:
   - the possibilities to optimize the utilisation of vehicles (reduction in the number of empty trips, more efficient route planning);
   - the consequences of logistical changes on the location of production and distribution centres (one could expect concentration as well as deconcentration tendencies);
   - the consequences of global logistical changes on the shifts in transport flows, the way of appearance of these flows and the usage of different forms of transport).
   - the insight in the consequences of a non-existence of high quality infrastructure and the problems to cross borders on the logistical organization of firms will facilitate the possibilities to foresee the consequences of the removal of bottle-necks and border problems.

c. This last point directly leads to a following emerging research issue: that of the financing of new infrastructure. Apart from the financial economic issues involved here an important technological issue is the exploration of the possibilities to collect funds from the users of this infrastructure according to their level of usage or according to the external effects they produce to others. Theoretically, systems of road pricing on individual basis are already feasible. The solution of all kinds of technical problems and the resistance towards the danger of 'big brother' developments obstructs the practical application of these concepts. Further research could indicate whether these problems could be solved.

d. The reduction of external effects of car traffic leads to the need to have an insight in the effectiveness of the instruments available to reduce these effects and to enable cost benefit analyses to be made. Extensive programs to reduce these negative external effects have already been developed. Technological developments alone seem to be insufficient to achieve the desired level of reduction of these problems. Therefore the trade off between additional technological investments and instruments that are aimed to reduce the level of mobility itself will emerge.
3.3 Gaps in knowledge

In order to be able to give adequate answers to the research issues mentioned before it is necessary that enough knowledge exists regarding the functioning of the TCM-system and the way this system will react on new developments such as the implementation of transport policies and the introduction of new technologies. At present the tools to elaborate such an evaluation seem rather limited. Especially in the following areas an extension of our present knowledge is required:

- Insight in the behaviour of firms regarding the way they will change their logistical organization using the emerging technologies to make integral logistical control feasible. At this moment a good insight in the present logistical organization is lacking; let alone that such views on the future situation exist.

- Insight in the way users of infrastructure (public transport travellers as well as users of car infrastructure) will change their travel behaviour due to new technological concepts. Apart from the impact of telematics the willingness of individuals to rely upon artificial intelligence is at stake here.

- Insight is missing in the way advanced information systems will influence the possibilities to achieve a more efficient transport system. Such an insight is necessary to determine the required level of infrastructural investments and to make cost benefit analysis regarding the implementation of such systems.

3.4 Emerging research directions

For some of the subjects mentioned above extensive R&D efforts are being carried out already, as well in industry as at universities and governmental institutions. The impression exists, especially in the area of infrastructure research that not enough combined effort in creating research opportunities has been made. This made a well balanced consideration of policy strategies regarding new technologies difficult. Especially in the field of freight transport there is an urgent need for data in order to indicate the consequences of the introduction of new technologies in a better way.

Summarising, the most important areas of research lay in:

- research regarding the consequences of the extended application of informatics on the logistical organization;

- research regarding the consequences of changes in the demand for transport and changes in the technological possibilities on the utilisation of infrastructure and the available means of transport.

Internationally there exists a need to achieve coordination, standardisation and harmonisation regarding infrastructure components, electronic data interchange and design concepts of vehicles. Such harmonisation is an essential prerequisite to
achieve cooperation on a European level in each of these areas. Especially in the area of information systems such cooperation is strongly needed. Also in developing supranational infrastructure projects such cooperation is essential to avoid duplication and unnecessary competition.

3.5 Theoretical Developments

In the area of technological context analysis there has not been a unified approach regarding the research methodologies used. Also the theoretical basis of this type of research is not very well developed.

In addressing the future scope for theoretical developments a distinction can be made between research methodologies that are aimed at solving a particular technological problem and research methodologies that are necessary to evaluate the feasibility or the consequences of new technologies.

Into the first category can be placed:
- Studies regarding the possibilities of applying optimisation strategies in passenger and freight transport. Especially the improvement of procedures and techniques for optimising personnel and transport equipment can be mentioned here.
- Improvement of technological concepts related to the design of vehicles, infrastructure, traffic control, avoiding negative external effects.

Into the second category fall:
- Methods to evaluate the consequences of applying new technologies. Especially the lack of sufficient and reliable data on firm behaviour is a prerequisite to improve existing techniques.
- Methods for carrying out before-and-after surveys or technology assessments in order to determine the effectiveness of new technological concepts.
4. BEHAVIOURAL ANALYSIS

4.1 Trends in behavioural patterns

4.1.1 Transportation

Typical aspects of the Netherlands which affect the travel behaviour of its residents are the relatively high population density and the high proportion of the population living in cities. This is one of the causes among other things of the intensive use of the bicycle in the Netherlands and the relatively dense public transport system.

One of the overwhelming trends of the last two decades is the strong increase in personal travel mobility. It is generally agreed that rising net incomes is a major reason for this development, leading among other things to rising personal car ownership. A growing number of households decided to spend an important part of their income on mobility through the acquisition of a car and subsequently to run their car in producing their own transport services. This behavioural trend resulted in a threefold increase in personal car ownership per thousand inhabitants from 104 in 1965 to 340 in 1985. The availability of a car enabled households to get more easily to their preferred dwelling locations in suburban or rural environments, the result of this process being increased distances between activity places such as home and work.

These three interrelated and mutually dependent factors (income, car ownership, distant locations) together form the main forces of the still growing travel demand of individuals.

The rise of the car and the increased distances led to a significant drop in bicycle use. The former predominant position of the bicycle, e.g. as the main mode for work trips, is now occupied by the car. This is a major cause for congestion in city centres.

The increase in mobility is not evenly distributed among categories. First, the increase is largest with persons having got access to a car. Second, travel mobility increased dominantly at intercity relations, to a large degree determined by past migration processes. Also international travel strongly increased. On the one hand, the steady development of a stronger international economic and commercial integration on a European and global scale induced a growth in international business travel. On the other hand, rising incomes enable persons to make more international trips for recreational purposes. The international travellers showed an increasing preference for using the aeroplane for their trips giving rise to a considerable increase in personal air travel.
With respect to the demand for goods transport there is a clear trend to ship the goods by using the faster modes: this means more transport by truck or aeroplane and less by ship or train. The reasons for this change in mode choice is first of all the change in the type and value of goods which reflects changes in the economy as well as in the production process of the goods (specialization, co-makership, just-in-time production etc.). In addition, changes in the supply characteristics of the various modes play a role, such as larger improvements in costs, travel times, and reliability in air and road transport compared to water and railway.

4.1.2 Communication

The last two decades have shown a strong increase in demand for all forms of communication. Overall, the rate of increase is more than a factor two. It is an expression of the development of the communication society.

The penetration of telephone connections in private households and firms is now near 100%. Household income is no longer prohibitive for having a telephone. The use of the telephone for private and business purposes has tripled in the last twenty years. The use of modern communication techniques such as telex and telefax grew at a much faster rate: telex-minutes increased for example by a factor five. To a certain degree telephone calls have become a substitute for other forms of communication including postal and physical contacts; on the other hand there has been a considerable amount of newly generated contacts because of the widespread availability and easy handling. Telephone contacts enabled people to enlarge their geographical contact field considerably: whereas local calls increased by a factor two-and-a-half, long distance calls grew by a factor four and international calls even by a factor twelve.

In general, communication for business purposes increased much faster than for private reasons.

Another feature of the growth in communication is the stronger international orientation: international telephone contacts increased by a factor twelve. One of the components of the increase in telephone contacts is certainly the increase in data communication between computers.

4.1.3 Mobility and location

A significant trend with respect to mobility decisions is the decision of households to move out of larger cities. In the past twenty years large streams of migrants left their original residential areas and settled in suburban and rural environments. The choice for a new residential location was mainly influenced by shortages in housing supply in the traditional cities on the one hand and the newly created housing supply on the other hand. Also preferences for particular types of resi-
dential environment played a role. In general, considerations of housing quality had a much larger influence on the decision to move than distance to work.

For many migrants, the decision to move was facilitated by the availability of a car with which the increased distances to work could be managed.

This home-induced migration as a consequence resulted in increased commuting distances of workers to their traditional working places: commuting as a complementary action to migration.

A second trend is the choice of working location farther away from home without subsequent change of the residential location. Also here various forces are at work. On the one hand, there are developments in the structure of employment (more specialization, etc.) and the bad situation on the housing market that led to growing distances between supply of and demand for jobs. On the other hand, improved travel conditions among other things through increased car ownership, facilitate workers to accept jobs at larger distances from home. Also in this case larger commuting distances are the result: this work-induced commuting is taken as a substitute for migration.

A recent trend similar in characteristics but starting later than the migration of households is the movement of firms and offices out of the central cities. This is especially the case with the services sector. This increase in suburban office location choice is due to lack of space at inner-city locations and better accessibility of the firm at the suburban places. In many cases this better accessibility is meant in terms of car access. Also this office migration in general leads to increasing home-to-work distances for employees, and to shifts in modal choice in favor of the car.

4.2 Research issues in behavioural research

4.2.1 Transportation

a. The most important issue in the field of transportation demand in the last two decades was modal choice for personal travel. Especially the choice between car and public transport was dealt with. The mode choice situation in The Netherlands is more complex than elsewhere because of the important role of the bicycle, especially in cities.

This issue mainly originated from two developments. On the one hand, there was the recognition of the negative impacts of the strongly growing car use for society, such as traffic congestion in city centres and on freeways, environmental effects (noise, air pollution), fuel consumption, etc. On the other hand, there was a stagnation in public transport use accompanied by serious financial deficits of public transport companies and authorities.
With respect to mode choice behaviour, the predominant research issue concerned measuring demand elasticities with respect to various mode characteristics (mode availability, fares, prices, travel times, comfort, etc.). In this respect, the value-of-travel-time is one of the mostly derived parameters to characterize mode choice behaviour. Also, choice constraints and subjective attitudes became important items in mode choice research.

General findings from the past research are among others:
- mode captivity is considerable, in many instances more than half of the travellers is constrained to a particular mode for their trip;
- travellers are not very sensitive to prices (or money costs);
- non-measurable, mode-specific attributes play an important role in mode preferences.

b. Within the general subject of choice between modes, a number of more specific research issues have been dealt with in the past, of which car ownership, parking in city centres, and public transport quality were the major subjects.

Much attention has been paid to car ownership and care use. The recognition that car availability is the major force behind car use led to studying the questions which factors contribute to the acquisition of (or the disposition of) cars by households. Many studies have been carried out into the effects of household variables (income, composition, age, etc.), location variables (proximity to public transport stops), prices of car use (acquisition, possession, operation, fuel), etc. upon the ownership and usage of cars.

c. Apart from studies into fare elasticities with respect to public transport demand, much research effort has been devoted to the effects of access and egress to stops and stations as well as to transfers. From these studies it has been learned, among other things, that the egress (non-home) trip-leg is much more important than the access-trip-leg at the home side of the traveller (because of the nearly full bicycle ownership). This means e.g. that public transport use for work trips can be significantly encouraged by locating major employment concentrations at public transport network nodes.

d. For trips within cities and regions, the bicycle is a major mode in The Netherlands (mode share of 40%) and is a strong competitor for public transport and the car. Much effort has been spend to find out how the bicycle system can be improved in order to consolidate or even strengthen the position of the bicycle relative to the other modes. It was found among other things that direct connections and a high network density are much more effective in stimulating bike use than concentrating investments in few, high-quality facilities.
4.2.2 Communication

Only recently, the potential effects of telematics upon the transport and communication behaviour of individuals and firms has become a major research issue. Main interest is in the effect of the introduction of all kinds of telecommunication services (teleshopping, telebanking, teleworking, etc.) upon the level of physical transport.

4.2.3 Mobility and location

A major issue in mobility research of the last two decades is the household's choice of residential location. Especially interurban migration received much attention because of its severe transportation consequences (commuting). The interest in housing location choice partly resulted from the negative effects of the suburbanization process in the large conurbations. On the other hand, insights in this choice behaviour were needed in formulating policies with respect to achieving a desired regional population distribution (new towns, growth-towns, compact-city-idea). Research questions concerned the effects of household variables, accessibility variables, and location variables upon the decision to change the housing location. Of special concern was the change in commuting distances.

Also the location and movement behaviour of firms and offices was a major research issue. Investigations were carried out into the reasons of firms to leave central city locations and to settle at suburban locations. One of the research questions dealt with was the influence of accessibility upon these decisions. Also the effect of the locational change upon the travel behaviour of the employees received much attention.

4.3. Gaps in behavioural knowledge

4.3.1 Transportation

a. Congestion effects on behaviour

Congestion in overloaded networks has become a widespread phenomenon in large parts of the country, especially during morning and evening peaks. It is important to know how the decrease in travel quality (losses in travel time and comfort, increased costs, unsafety and unreliability, etc.) influences generation, mode choice, time choice, route choice, etc. of travellers and goods shippers. The same applies to the effects of toll charges levied in congested situations. Especially, the distributional effects with respect to the type of travellers and transport being harmed are relevant. In addition to the direct responses of actors through changed travel decisions also the impact on second-level mobility and location decisions, such as with respect to jobs, education, etc. are important.
b. Positive effects of mobility increase

In the past much transportation research was undertaken as a response to the negative effects of growing car use (congestion, environmental deterioration, etc.) and was therefore often directed at limiting the increase in mobility. The benefits of good transportation opportunities and travel quality to the population are widely neglected as a research subject. It is necessary to know more about the positive effects for individual actors that can be gained by a higher mobility level, such as better accessibility to (better) jobs, better accessibility to education, increased household income, improved opportunities to sell products, etc.

c. Car acquisition process

Car ownership is a key variable in travel decisions. Despite twenty years of research into car acquisition changes in car ownership appear difficult to predict. Continuous changes in household types and structure, life styles, etc. as well as in car supply (types, technology, etc.) among other things demand for continuing research efforts. Also insights derived in a period of steadily improving conditions with respect to income, traffic, etc. may not be valid in times of decline. Relevant questions with respect to car ownership are among others the moment of (first and second) car acquisition relative to other household state variables, and the effects of job and locational changes in the household upon acquisition decisions.

d. Personal travel demand for business and commercial purposes

In order to gain better insights into the significance of good travel conditions for the economy more research is needed into the characteristics of personal travel for business and commercial purposes. Relevant questions are among others: mode choice (value-of-time, effect of time reliability, effect of congestion), substitution with telecommunication, timing, mileages.

e. Goods transportation demand

There is a need for a theory about the goods transportation process leading to predictive models for goods movements and consequently goods transporting vehicle movements. The theory should be able to predict effects of changes in production structure with respect to type of intermediate and final goods as well as location of firms. Also the shippers' mode choice behaviour should be given attention. This theory will be much more complex than in the case of personal travel demand: there are many more different agents involved with their own preferences: final consumers, intermediate consumers, shippers, carriers, producers.
4.3.2 Communication

The era has already started where telecommunication has become a serious competitor of physical transport. Research is needed into the characteristics of new telecommunication services and their effects upon the interaction and location/mobility behaviour of individuals and firms. Relevant questions are among others:
- acquisition of telecom equipment in the household and firm, and its use;
- changes in activity pattern;
- changes in telecommunication and travel habits: substitution and generation effects with respect to interaction frequency, modal choice, time choice, etc.;
- changes in residential location.
Especially, the response of business firms on telecommunication services with respect to personal travel, goods transport, and at a higher level, on locational choices, needs investigation.

On the supply side, research is needed into the possibilities that telematics offers to improve travel conditions and hence capacities, e.g. through route guidance, early warning systems, etc..

4.3.3 Location and mobility

There is a general lack of knowledge into the locational choice behaviour of firms. On the one hand, transportation related variables may affect these decisions to a large extent; on the other hand, the outcome of these decisions exert a great influence upon the travel pattern of employees and clients, as well as on the distribution of goods. Apart from physical accessibility, also access to the telecommunication network has recently become a relevant location factor to investigate.

4.4. Emerging research directions

4.4.1 Transportation

The research directions that emerged in recent years partly developed out of old problems where still gaps in knowledge exist (e.g. effects of congestion) and partly originate from changes in the socio-economic context (e.g. household characteristics, telematics). Ongoing research already mentioned as 'gaps' (see 4.3) concerns among others:
- effects of congestion upon travel, mobility, and locational behaviour;
- determinants of car ownership;
- effects of new telecommunication services upon travel and locational behaviour.

Stimulated by the recent economic recession projects have been initiated into the effects of a decline in socio-economic con-
ditions of households and individuals (e.g. getting unemployed, income decline, decreasing car ownership) upon their travel behaviour. In a more general sense, various rapidly changing socio-economic conditions such as:
- in the household's or individual's employment status;
- in working times;
- in household size and structure;
- in household income,
are studied with respect to their effects upon mobility (car ownership, residential location) and travel decisions.

Despite the strong decline in interurban migration in recent years, interurban commuting is still growing. In order to identify the various causes of this process new research projects have been initiated recently.

In the past much of the research stressed the spatial component of transport. It has been recognized however that many of the problems are caused by the time component inherently attached with travel decisions. A lot of research has been started in recent years into time decision making of households and individuals. An important part of these studies deals with daily and weekly activity scheduling and investigates actual or potential responses (changes in timing or even rescheduling of activity patterns) to increasing road congestion, introduction of congestion tolls, diminishing or improving public transport services, changes in household characteristics (e.g. employment).

Along with the interest in behavioural responses to changed conditions there is a growing need for research techniques enabling the analysis of dynamics in behaviour. Such techniques are being developed in the course of the national longitudinal transportation panel survey.

Long distance and international travel, especially for business purposes, has become more important during the last decades. New services such as high speed trains have been developed to meet this demand. A lot of studies have been initiated to get a better insight into the characteristics of this market segment. The potential effects of new rail lines for long distance travel and of high speed rail services upon choice behaviour of this category of travellers are subject of these studies.

4.4.2 Communication

A fastly growing body of recent research deals with the relationship between telematics and TCM. On the supply side, studies deal with the location, configuration and implementation of high-level telecommunication networks in cities (Amsterdam, Rotterdam) and at the national scale. Many demand studies are underway investigating the demand for telematic services for individuals, households and firms, and possible substitution effects between communication and physical transport both for personal and goods transport.
4.4.3 Location and mobility

The location choice behaviour of firms and offices attracts an increased attention in recent years. From a transportation point-of-view questions are dealt with such as effects of introduction of telematics, road congestion, new rail lines, upon locational choice and upon spatial concentration/deconcentration of business activities.

4.5 Theoretical developments

4.5.1 Transportation

In the past two decades most attention has been paid to the theory of modal choice and related subjects such as car availability. Also route choice theory attracted much effort of Dutch researchers. Characteristic for theory development in the past was among others the recognition of travel as a derived demand and travel as the result of individual decision making.

a. Most progress was achieved through development and application of random-utility discrete-choice theory for separate and linked travel choices. In the course of this theory development, ample attention was given to notions like individual choice set, captivity, preference (utility) functions representing the way individuals evaluate attributes of alternatives.

Earliest steps in the development involved considering trips as independent choices and used simple utility functions. Also options were considered as being independent. At later stages dependencies between trips and choices were taken into account such as with the tour-concept. More recently, refinements were being introduced with respect to among others types of preference functions and relationships between alternatives. A recent development too is the recognition of the importance of individual constraints with respect to travel choices: earlier insights about mode captivity, mostly dealing with car availability are being enlarged by a more general treatment of constrained choices with respect to various modes.

b. Apart from micro-economic based approaches, also theories from the fields of psychology and sociology have been adopted. Especially modal choice has been studied using among other things Fishbein's attitude theory which takes normative beliefs into account.

c. Using equilibrium theory the effects of limited capacities upon demand was studied. Contributions to this theory (especially solution algorithms) were developed in the course of studies into the future development of the national high-level road network.
d. Significant attention received the development and use of space-time activity scheduling theories. A first step in this development was the hypothesis of a constant travel budget for personal travel needs. Most of the activity studies deal with the effects of changing conditions (e.g. in household composition, employment characteristics, public transport services, shopping hours) upon the scheduling of activities and consequently on the travel behaviour. A dominant role in the analyses plays the existence of all kinds of constraints that limit the possibilities of adapting behaviour. With respect to dynamics, theories hypothesizing maximum preservation of traditional behavioural patterns (e.g. Festinger's cognitive dissonance theory) are favoured.

4.5.2 Location and mobility

Based on the success of discrete choice models in travel behaviour research, also in residential location choice the microeconomic based discrete-choice theory has been adopted to study preferences for location characteristics and to learn about trade-offs made by households. This approach has been widened to the joint choice of housing and working location in order to formulate models explaining migration and commuting behaviour. More recently, the locational behaviour of firms and offices has been investigated within this theoretical framework.

4.6. Analytical tools in transportation research

Most of the new analytical tools have been developed and used in the course of modelling individual choice behaviour. Predominant here are the mathematical approaches and statistical estimation techniques. The utility (preference) functions mostly are estimated on the basis of the logit specification of the choice models using cross-sectional revealed preference data. The type of data used in estimation has been widened gradually. Many applications of stated preference data and related estimation techniques (conjoint measurement) have been used to derive behavioural parameters. In some cases-model estimation was done using longitudinal data stemming from before-and-after studies or from panel surveys. Application of these techniques was not at all restricted to modal choice but covered also route choice, destination choice, train type choice, parking choice, etc.

A second class of approaches may be labelled as micro-simulation techniques. Two types of simulation approaches can be distinguished. The quantitative approaches are used to estimate probabilistic choice models having a complex structure. Examples are known for parking choice behaviour and route choice. For even more complex situations, such as with activity schedules, qualitative simulation has been used. With these simulations the probable responses in activity and travel choices to hypothetical changes in background conditions are assessed. An important outcome of such simulations is the degree of free-
dom-of-choice and the types and severeness of constraints that limit individuals to change their behaviour. Applications are known, among others, of the HATS- and CARLA- techniques to study the behavioural response pattern to improvements in rural public transport services and of the situational approach to study the constraints structure in mode choice.

Most of the older research was based on cross-sectional data. In order to circumvent a number of drawbacks of this approach a systematic collection of longitudinal travel data for a panel of households has been started by the government a number of years ago. These longitudinal panel data are used to analyse changes in behaviour, especially mode choice, in response to changes in various background conditions such as fares, fuel prices, household changes, etc. Turn-over tables are one of the techniques to determine individual response effects from this type of data.
5. POLICY ANALYSIS

5.0 Introduction

In this section, dedicated to policy analysis, megatrends, research issues and analytical tools will be discussed that are considered relevant to policy preparation, policy formulation and the evaluation of the impacts of policy implementation. As the TCM policy has strongly been influenced since the middle of the seventies by three megatrends the research issues here will be related as much as possible to one or more of these three trends.

5.1 Megatrends

During the last decade the TCM policy in the Netherlands has strongly been influenced by some partly interlinked megatrends:

5.1.1 a desire to lower the level of public expenditure
5.1.2 a trend towards less government intervention
5.1.3 an increasing social and economic integration of the various parts of the world

5.1.1. The pressure to reduce public spending can be considered as a strong incentive for reconsidering the many-sided government intervention in the transport and communication sector, which was gradually building-up between the mid-fifties and the mid-seventies. This reduction of public spending followed a long period of increasing public expenditure, made possible by the gradual rise in GNP and the increasing state-earnings from natural gas sales. This push from the side of available resources went hand in hand with the pull to create a social welfare-state. Transport was seen as an important instrument variable to achieve a better quality of life. Transport in this connection had to function as a tool to fulfill the objectives of physical and environmental planning. Increasing car-ownership resulted in a declining share of public transport in the total mobility. Given the high level of public transport services maintained, the amounts of money needed to finance the deficits showed an exponential development. At the same time other areas of government responsibilities claimed fast increasing amounts of public resources. The economic recessions in the seventies all of a sudden made it clear that public expenditures should be reconsidered. Not only the exponential development in government spending had to be halted, but a downward trend had to be started. Under these circumstances a reconsideration of the effectiveness of
public expenditure in the transport sector was unavoidable.

5.1.2. As mentioned before, the need to bring down the level of public spending was an incentive to analyse the effectiveness of that spending, given the objectives of government's involvement.

- In the transport sector the effectiveness of the public transport policy asked for special attention. An analysis of the results achieved with 14 years of high subsidies brought into the open that the increase in mobility during that period was fully due to extra car trips.

However, the reconsideration of government's involvement was not wholly induced by the need to bring down public expenditure. The overall effectiveness of the trend-setting government policy was criticised more and more, given the disappointing results:

- Land-use patterns adapted themselves fully to the possibilities opened by the private car and did not follow the objectives of the environmental planners.
- Government's steering power in freight transport failed under conditions of declining economic activities.
- The overattention that was given during a long period of time to the mobility needs of the private households had as consequence that the need for adequate facilities on behalf of the production households was neglected. Decreasing accessibility of the traditional economic centres made them lose their attractiveness as a location. A decline in employment in those areas was setting in.

The disappointing results of the various forms of government intervention in the transport sector asked for a reorientation.

In 1982 the Netherlands' government actually started a deregulation policy, extra pressed by the negative side effects of the many regulations, becoming evident since the recession of the late seventies.

5.1.3 With this we reach the third mentioned megatrend: the increasing social and economic integration of the various parts of the world. Since the last two decades some fundamental changes in the social and economic patterns took place and did so with an increasing intensity and speed.

Stimulated by technological developments the spatial distribution of economic activities changes.

As the economy of the Netherlands is strongly dependent on its international distribution function, the developments mentioned requires special attention. The
traditional distribution channels and systems are no longer optimal. The relative position of the Port of Rotterdam within these global distribution systems becomes less secure. New facilities are needed, adapted to the changed conditions and needs. These changes in the social and economic patterns have also resulted in a re-orientation on the objectives for environmental planning.

5.2 Research issues

5.2.1 The need for government intervention.
Since the importance of the railways as an instrument variable is declining in many areas of economic and social activities and road transport has to provide an increasing part of the transport services, the needs for regulation ask for a reconsideration. As was mentioned before, a general trend towards deregulation in the Netherlands was set in during the beginning of the eighties.
A detailed analysis of that functioning under a more liberal policy is needed to find a reliable basis for re-regulations.
The experiences with the functioning of the transport sector under various forms and degrees of government intervention should therefore be studied in detail.

5.2.2 The effectiveness of the transport sector as an instrument variable.
Given the disappointing results in this connection of the achievement of the objective for environmental planning and regional development, a detailed analysis is needed of the conditions under which the use of transport facilities as an instrument variable can be successful.

5.2.3 In spite of the large amounts of public funds used for subsidising public transport over a long period of time, this form of passenger transport has lost ground. A reconsideration of the public transport policy is therefore necessary.
The public funds, allocated to the stimulation of public transport patronage should be used to handle other instruments than low fares. An analysis of the sensitivity of the modal choice for quality improvement should be given a high priority.
More or less implicitly the rather emotional point will have to be answered, whether a more market oriented public transport policy can be successful if with one and the same system the following three categories of passengers have to be served:
- the car owners asking for a high quality of service
- the elderly and the handicapped, needing adapted facilities and
- the poor, demanding cheap public transport services.
5.3 Gaps in knowledge

From the research issues discussed in section 5.2 follows that with each of these issues at least one gap in knowledge is related:

5.3.1 The degree of regulation, needed for a proper economic functioning of the various modes of transport and the most desirable forms of regulation, per mode.

5.3.2 The relevance and relative weight of transport facilities for environmental planning and regional development, under various local conditions.

5.3.3 The sensitivity of the modal choice of car owners for various quality of service elements in public transport.

5.4 Emerging research directions

5.4.1 The necessity to reduce the volume of public spending gave a strong incentive to look for new approaches in governmental management. Questions like:
- What transport-related services have to be provided by the government because of the need to exercise typical public authority.
- What degree of centralisation or decentralisation is needed to implement government's intervention.
- How to improve the consistency in intervention both along horizontal and vertical lines within the total government system, require a reconsideration of structures that have proved to be very resistant to change-initiatives.

5.4.2 In the transport policy approach at Common Market level progress was up till now almost blocked by the fundamental difference of opinion between continental countries like Germany and France, opposite the more global oriented countries like the UK and The Netherlands.
A deal to reach a next step in liberalisation is always conditioned with a demand for harmonisation of the competitive terms.
However, since the globalisation of the economic activities has as consequence that the West-European industry has to widen its markets outside Western Europe, the cost level of the freight transport services together with their sophisticatedness have become of strategic relevance for the future of Western Europe.
Research into this relevance and into the possibility to strengthen the competitive position by the development of adequate logistic systems has started.
Research work has started to improve the professionalism of management in government-owned companies.

The desire to cope with the negative external effects of (auto) mobility resulted in many experiments at national level as well as at municipal level. To check whether these various experiments brought the desired results, evaluation studies were introduced.

Theoretical developments

The mobility and location patterns that developed during the last decades were not only in conflict with the policy objectives, but asked at the same time for a reconsideration of the basic assumptions used in the policy preparation.

Many theoretical constructions used as a justification for an intensive government intervention, especially in the area of freight transport, define the total demand for freight transport services as inelastic. The incorrectness of this assumption is evident. The interdependence between demand for and supply of transport facilities has therefore to be elaborated and the impact of this interdependence integrated in the freight transport policy.

Analytical tools

As mentioned before, many experiments have been done to test the effectiveness of policy tools. Before and after studies were the most frequently used analytical tool.

Analyses on a broader scale focussed on the evaluation of the results of a specific policy line.

To test the effectiveness of policy alternatives in the stage of policy preparation, simulation techniques were developed and applied to estimate the impacts of the alternatives.
6. PROSPECTS

Need for integration

The division of the TCM field into four clusters caused serious difficulties. It caused many artificial demarcation problems to the respondents as well as to the writers of the national report. The interaction between context, behaviour and policy is so strong that it is hardly possible to tackle research problems that fit into one specific cluster. It is therefore strongly recommended to abandon this subdivision when research proposals are to be formulated for the second phase of the ESF-network.

The distinction between transport, communication and mobility makes more sense since research problems may be identified within each of these fields. It should be remembered, however, that very interesting and relevant themes for research may be found on the borderlines. Examples are: interaction between transport and telecommunication, inter-relationships between transport and household and firm mobility, etc. It is therefore proposed not to organize future research strictly according to this subdivision.

Scope for cross-national research cooperation

Cross-national research cooperation may be valuable for a number of reasons:
- if the phenomenon to be investigated has an international dimension, it is more efficient to have partners in various countries;
- comparison between countries may reveal the nature and underlying relationships of essentially national phenomena;
- international funding can be obtained;
- exchange of views between researchers with quite different academic traditions can take place;
- foreign literature is more accessible.

These are potential advantages which can be gained only if certain conditions are met. A drawback which will hamper the international collaboration is the fact that ESF will probably not fund local research efforts made as part of a collaborative program. In our country consultancies are therefore will hardly be interested in participating. This means that funds have to be raised on a national base. This makes coordination in terms of problem statements and methodology more complicated since local sponsors have different interests, priorities and budget constraints. As a result of this the synchronization of the activities in various countries will be rather difficult as well.

In order to make collaborative research projects successful we think that the following conditions should be met:
1. Start with rather small teams in which a limited number of countries participate. This limits the problems of funding and coordination of tasks.

2. Since the success of a research effort largely depends on the quality, shared interests and team spirit of individual researchers, it is essential to form research teams that for a larger part exist of individuals that have common interest in the research problem and in working together.

3. Start with well-defined research projects of a limited scope and aimed at solving specific problems. Do not try to formulate all-embracing projects of a very general nature. In the beginning it is essential to have some projects started quickly and to show some early results, preferably successes.

4. In the Netherlands local funding will have to be provided mainly by the Ministry of Transport and Public Works and the Ministry of Housing Spatial Planning and the Environment.

This implies that it is necessary to formulate proposals having a certain policy-relevance. From a point of view of funding it is a disadvantage that the Dutch Science Foundation has no specific section on transport. Getting funds for our projects from this source is therefore somewhat more difficult.

Some research problems

Many suggestions for future research were put forward in the earlier sections on gaps in knowledge and research directions with respect to the four clusters. There is no need to repeat them here extensively. They will be summed up under two headings: (1) cross-national comparisons and (2) international phenomena or policies.

(1) cross-national comparisons

The context of TCM-phenomena differs between countries which gives the opportunity to gain additional insights into their backgrounds. Furthermore, some countries are ahead of others with respect to some general developments in TCM-patterns and behaviour which implies that important future problems can be identified from international comparisons. Finally, by analysing TCM-policies that have been adopted in various countries with respect to their effects, important lessons can be learned about the effectiveness of specific measures as well as more importantly in the ESF-context, about TCM-behaviour.

The following interesting research areas can be mentioned:
- the effects of demographic and socio-economic changes on personal travel demand;
- business travel: volumes, characteristics, backgrounds and theory;
- the effect of telecommunication on the demand for personal travel;
- the effect of congestion on travel behaviour and locational behaviour;
- choice behaviour of travellers with respect to time of travel;
- car ownership behaviour of households;
- modal choice behaviour of car owners with emphasis on quality of public transport service;
- the effect of new telecommunication and information technologies on the logistics of firms;
- goods transport: characteristics and theory with emphasis on the effects of technological developments;
- the effect of technological developments on the efficiency of both personal transport and goods transport;
- theory development of locational behaviour of firms with emphasis on the effect of new telecommunications techniques;
- the importance of transport facilities for regional development and the globalisation of various economic activities.

(2) International phenomena or policy issues

Due to rapid economic integration and to the increase in gross national product international transport, communication and mobility is growing quickly. There is a growing need for international TCM-policies and indeed the EC is gradually taking on its role in this field. This means that much more needs to be known about international TCM-patterns and behaviour in order to develop and test Community policy measures. Interesting research themes of this type are:
- international travel, in particular business travel and leisure travel: volumes, characteristics and backgrounds;
- the effect of EC-integration, in particular of harmonisation, on the efficiency of the transport sector.
Appendix-I: Theme report socio-economic context analysis

Coordinator: G.R.M. Jansen
1. Introduction

In the framework of this survey socio-economic context is defined as the demographic, social and economic aspects of society that affect the TCM-pattern. For pragmatic reasons geographic aspects will be dealt with in this theme although they easily could be seen as the result of certain mobility decisions.

In accordance with the general set-up of this survey only the effect of the socio-economic context upon the TCM-pattern is discussed. The reverse relationship dealing with the effect of TCM upon the socio-economic aspects of society, is not treated here. Little research has been carried out on this latter subject in this country, anyhow. It has been tried to treat transport, mobility and telecommunication in equal detail in this survey. Given the amount of research on these three themes in The Netherlands it not surprising that personal travel will be the main item.


2.1. General

In this section the most important trends of the socio-economic context of the TCM-pattern in the Netherlands are described. Only developments that have affected this pattern will be discussed.

Four dimensions of the socio-economic context are distinguished: the demographic, socio-economic, economic and geographical dimension. Of course, these aspects are interrelated in many respects.

2.2. Demographic trends

Total population

Quick changes took place in the growth pattern and composition of the Dutch population. Table 1 shows the key figures of these changes. After a period of rapid growth between 1945-1965, when the average annual population growth rate was ca. 1.5%, population growth declined during the last two decades. Growth rate fell steadily from ca. 1.3% in 1965 to 0.4% in 1985. Decline seems to have levelled off now.

Age distribution

The large decrease of the birth rate resulted in a dramatic drop in the number young people. Whereas total population still rose the number of inhabitants under 19 fell by half a million resulting in a sharp reduction in its share from ca. 38% in 1965 to ca. 28% in 1985. At the same time the number of inhabitants aged 20-64 rose by two million (+33%) due to the high birth rates of twenty to forty years ago. From this age group the labour force is recruited. This trend is expected to continue in the coming decades. It may be expected that these changes have affected and will further affect the travel patterns. Research showed that both these demographic trends will result in an increase in car travel and in a reduction in bicycle and public transport use. In particular, travel
to and from work will grow, whereas travel with educational purposes will decrease significantly. These are purely demographic effects [1,2].

Household size
Another major demographic and social trend refers to household size. Due to changes in lifestyle, partly enabled by favourable economic conditions, and demographic processes, average household size fell significantly between 1965 and 1985. As is shown by Table 2 the number of households increased much faster than the population. In particular, the number of small households of one and two persons nearly doubled; its proportion increased to 54% since 1985. This trend affected population densities and the need for housing significantly.

Table 1: Changes in population by age group (numbers in thousands)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number</th>
<th>index</th>
<th>age 0-19 number</th>
<th>%</th>
<th>index</th>
<th>age 20-64 number</th>
<th>%</th>
<th>index</th>
<th>age 65+ number</th>
<th>%</th>
<th>index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>12,377</td>
<td>100</td>
<td>4,679</td>
<td>37.8</td>
<td>100</td>
<td>6,510</td>
<td>52.6</td>
<td>100</td>
<td>1,188</td>
<td>9.6</td>
<td>100</td>
</tr>
<tr>
<td>1975</td>
<td>13,599</td>
<td>110</td>
<td>4,651</td>
<td>34.2</td>
<td>99</td>
<td>7,347</td>
<td>55.5</td>
<td>116</td>
<td>1,482</td>
<td>10.9</td>
<td>125</td>
</tr>
<tr>
<td>1985</td>
<td>14,453</td>
<td>117</td>
<td>4,090</td>
<td>28.3</td>
<td>87</td>
<td>8,643</td>
<td>59.8</td>
<td>133</td>
<td>1,734</td>
<td>12.0</td>
<td>146</td>
</tr>
</tbody>
</table>

Source: CBS

Table 2: Changes in number of households by type (numbers in thousands)

<table>
<thead>
<tr>
<th>Year</th>
<th>total number</th>
<th>index</th>
<th>one person households number</th>
<th>%</th>
<th>index</th>
<th>multi-person households number</th>
<th>%</th>
<th>index</th>
<th>household size number</th>
<th>%</th>
<th>index</th>
<th>% one and two person households</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>3,881</td>
<td>100</td>
<td>764</td>
<td>100</td>
<td></td>
<td>3,117</td>
<td>100</td>
<td></td>
<td>3.19</td>
<td>100</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>1975</td>
<td>4,561</td>
<td>118</td>
<td>883</td>
<td>110</td>
<td></td>
<td>3,768</td>
<td>118</td>
<td></td>
<td>2.95</td>
<td>92</td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>1985</td>
<td>5,622</td>
<td>142</td>
<td>1,437</td>
<td>188</td>
<td></td>
<td>4,085</td>
<td>131</td>
<td></td>
<td>2.58</td>
<td>81</td>
<td></td>
<td>54</td>
</tr>
</tbody>
</table>

Source: CBS

2.3 Socio-economic trends

In this section the socio-economic development of the Dutch population between 1965-1985 is discussed. We confine ourselves to four aspects, each exhibiting significant changes with effects on TCM-patterns:
- income,
- employment status,
- car ownership,
- flexibility.

Income
In the last two decades the Dutch economy showed a transition from rapid growth to stagnation. Although most West-European countries experienced the same growth pattern, the economic recession of 1982-1984 in The Netherlands was extremely severe. Table 3 shows the growth rate of real wages in our country. Wages can be regarded as a relevant indicator of the economic situation when analysing the socio-economic context of TCM-patterns. Personal travel and vehicle ownership is highly correlated with
income. It can be seen that the large wage increase during the early seventies quickly turned into significant real wage cuts in the early eighties. In particular between 1979 and 1984 real wages in The Netherlands fell much more than in Germany and the United Kingdom.

### Table 3: Cumulative increase in real wages between 1970-1984 (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The Netherlands</td>
<td>28.4%</td>
<td>6.8%</td>
<td>-9.8%</td>
</tr>
<tr>
<td>Germany</td>
<td>26.2%</td>
<td>12.4%</td>
<td>5.3%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>25.8%</td>
<td>0.0%</td>
<td>5.1%</td>
</tr>
</tbody>
</table>


Although household income, as a major determinant of personal travel, is not identical to the individual worker's wage, personal travel may be assumed to be affected by this downward trend. Research indicates that an income rise results in a general increase of travel. Income elasticity is highest for car travel [3,4]. It is therefore likely that the observed stagnation in mobility trends in the early eighties stems from a lack of income growth. The increase in the average number of workers per household and the shift to cheaper transport have not offset this reduction.

### Employment

Three major interrelated trends related to employment can be observed during the last two decades:

- large increase of unemployed workers,
- increase of employed married women,
- increase in part-time employment.

In The Netherlands unemployment is largely caused by insufficient economic growth together with a large increase in the supply of labour. This latter factor can be regarded as a typical Dutch circumstance compared to other West-European countries. First, the growth of the labour force stems from the demographic development in this country (see above), causing a significant growth of population aged 19-64. Furthermore, the rapidly increasing demand for jobs by married women plays an important role.

Table 4 clearly shows the rapid rise of the number of unemployed together with an increase in the labour force during the early eighties. Despite the severe economic recession a rise in the number of employed persons can be noticed. This has important consequences for work travel.

Another major trend with respect to employment is the sharp increase in the number of employed married women. Between 1961 and 1981 the proportion of married women that is employed or looking for employment increased from 7% to 33% [5, appendices 5.1-5.2]. Figure 5 illustrates this change and shows that the participation increased in all age groups under 55. Demographic developments like the reduction of the number of children per household are an important factor. On the other hand Dutch society is lagging behind neighbouring countries in this respect. Corresponding participation figures in 1979 are: Germany, 36%; U.K. 46%; France 44%; Denmark 53% [6]. From this it may be concluded that in addition to demographic factors other cultural forces cause this shift.
Table 4: Unemployment and labour force in The Netherlands 1975-1985, measured in persons

<table>
<thead>
<tr>
<th>Year/period</th>
<th>Unemployment % of labour force</th>
<th>Yearly rate of change in employment (%)</th>
<th>Yearly rate of change in labour force (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>5.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1975-1979</td>
<td>-</td>
<td>+1.0</td>
<td>+1.0</td>
</tr>
<tr>
<td>1980</td>
<td>6.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1980-1984</td>
<td>-</td>
<td>+0.6</td>
<td>+2.3</td>
</tr>
<tr>
<td>1985</td>
<td>14.5</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>


Figure 5: Labour force participation of married women by age group, 1960-1981.

Source: [5, p. 193]

It may be assumed that the growing number of employed married women affects travel patterns significantly. Not only the rise of the total number of employed persons results in an increase of home-to-work travel, but within the households travel behaviour becomes more complicated. There is a growing number of two-worker-households, within which individual trips have to be co-ordinated as to car use, trip timings etc. In addition, decreasing wages are compensated by the fact that women take on jobs with probable effects on car-ownership.

The third trend to be discussed here is the increasing number of part-time jobs. Table 6 shows this trend and indicates that part-time jobs of less than 25 hours per week are predominantly taken by women. Figures not included here show that in particular married women work part-time. This means that the number of work trips does not increase at the same rate as the number of employed persons.
Car ownership

Although it may be argued that household car ownership is an element of the TCM-pattern, we decided to deal with it here as an aspect of the socio-economic context. This item is treated more extensively in chapter 4 with respect to the behavioural aspects. Table 7 shows that between 1965 and 1985 car ownership trebled. In the early eighties growth in car ownership seems to have levelled off due to the economic recession, but recent statistics indicate that motorization resumed its growth.

This rapid growth is a major force of the changes in mobility and travel patterns. Total distance travelled per capita increased almost linearly with car ownership and massive suburbanisation was stimulated by the car.

Table 7: Car ownership 1965-1985

<table>
<thead>
<tr>
<th>Year</th>
<th>no. of cars x 1000</th>
<th>cars per 1000 inh.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>1.273</td>
<td>104</td>
</tr>
<tr>
<td>1970</td>
<td>2.258</td>
<td>174</td>
</tr>
<tr>
<td>1975</td>
<td>3.399</td>
<td>250</td>
</tr>
<tr>
<td>1980</td>
<td>4.515</td>
<td>320</td>
</tr>
<tr>
<td>1985</td>
<td>4.901</td>
<td>339</td>
</tr>
</tbody>
</table>

Source: CBS

Flexibility

The last trend to be mentioned here is the increase in flexibility and differentiation in the societal organisation. Important aspects are the multitude of household types, less rigid and fixed working times, flexible pensioning ages, more individual educational programmes, individual holiday schemes, etc. This phenomenon will affect activity schedules and through that travel patterns.

2.4. Economic trends

Two economic trends will be briefly discussed here. They both deal with the organization of the production. The first development is the so-called dematerialization of the economy: in the Dutch industrial sector a shift is going on towards the production of low-weight-high-value products. This means that per unit of national product a decreasing weight of commodities is used. Statistics indeed show a more or less constant volume of goods transported since 1978. The shift towards high-value products together
with newly developed logistical management procedures, leads to an increased use of the truck in freight transport.

Another important trend is the globalisation or internationalization of the economy, leading to growing commodity flows between The Netherlands and other European countries as well as with the USA and South-East Asia. The share of the truck in international freight transport is increasing because of the type products transported and the logistical context transport takes place in. As a result international truck transport is growing quickly.

Given the changing nature of the products, international truck traffic to and from The Netherlands is growing rapidly. This volume rose from 47 million tonnes in 1980 to 91 million tonnes in 1986.

2.5 Geographic trends

It was decided to treat geographical trends here, although they are partly the consequence of mobility decisions and as such part of the object rather than of the TCM-context.

Suburbanization of the population and to a lesser degree of employment is important development of the last two decades. It should be realized that The Netherlands was already a highly urbanized country in 1965. Between 1970 and 1985 the central cities of the four large metropolitan areas (Amsterdam, Rotterdam, Den Haag and Utrecht) lost 20% of their population to their suburban rings, which as a result grew by more than 40%. Taken these areas together this means an outward shift of about 500,000 people, with tremendous consequences for traffic patterns. Suburbanization was enabled by increased car ownership so it is no surprise that huge car traffic flows developed to and within the urban areas.

Employment did not move out of the central cities to the same extent: the absolute number of jobs remained constant whereas employment increased in suburban rings.

This suburbanization is one cause of increased commuting that has been observed between 1965 and 1985. Other causes are labour market specialization, car ownership, higher income, regional and housing policies. The share of workers that commuted between different municipalities increased from 27% in 1961 to 52% in 1985.

3. Important research issues

During the last two decades a number of serious problems developed with respect to the transportation system:

- widespread congestion on the motorway system in the Randstad area,
- large and rapidly growing deficits in public transport,
- environmental effects of car traffic e.g. noise and air pollution,
- deterioration of the favourable conditions for cycling and walking in cities,
- road safety.

Studies were initiated along various lines to identify causes of these problems and possible solutions. With respect to the socio-economic context the following research issues that received attention in our country can be mentioned.
a. Spatial activity patterns and travel
Relocation of households and firms has affected travel patterns to a large extent. Therefore a lot of research has been carried out in the seventies in order to gain understanding of the interdependence of travel patterns and moving and locational behaviour. Behavioural studies are reported in chapter 4. Attempts to model these interrelationships in a simultaneous way using **Lowry**-type models were not successful.

Later the Netherlands Economic Institute analysed the dynamic relationship between household migration, job change and home-to-work travel in great detail [7].

More recently a more pragmatic approach was adopted to analyse the effect of spatial activity patterns on travel patterns in an undirectional way: given alternative spatial distributions of population and employment the resulting traffic flows are calculated using sophisticated transport models. E.g. **Zuidvleugel** study [8], **Bolt** study [9] and the Strategic Study Randstad [10].

b. Car ownership analysis
Since car ownership analyses were mainly made at the individual level these are discussed in chapter 4.

c. Travel patterns and the economy
Since 1979 it became clear that the economic situation has a significant influence on travel patterns. During the severe economic recession of 1982-1984 long term trends in traffic volumes were discontinued. Existing forecasts apparently were based upon the assumption that: the economy would develop in a continuous way. A crucial research issue was therefore the relationship between the economic situation and transport, which was (and is) hardly understood. It is an extremely complex relationship since it deals both with personal travel and goods transport. Personal travel for instance is affected through income changes, price changes, subsidies, (un)employment etc.

Investigations were made into the effect of income decline on travel; See [3,11], where also an extensive review of Dutch research on the effect of the economy on travel can be found.

d. Employment status and travel
In this country an increasing proportion of married women is employed; the number of part-time jobs is rising quickly and the number of unemployed is high. At the same time Dutch government in agreement with the employers and unions has a policy to reduce the regular working week from 40 to 36 hours. These developments affect travel patterns in a way that is poorly understood.

Partially, these consequences were investigated. For instance, Delft University of Technology analysed the effect of job status (no job, full-time job, part-time job) on total travel by comparing mobility of various classes of households having different numbers of workers [12]. At the same institute extensive study was made of travel patterns of married women.

The effect of a reduction of the working week on travel and in particular on peak travel was analysed in two simulation studies [13,14].
4. Gaps in knowledge

Generally, the feeling is that even after 20 years of rather extensive research into TCM, in fact understanding of the impacts of the socio-economic context on travel and transport is still limited. Circumstances seem to change more rapidly than research can provide well-founded and insights. In fact, many gaps in existing knowledge of the effects of the socio-economic context could be mentioned. We will restrict ourselves to three.

1. Goods transport
Compared to personal travel even less is known about the effects of the economic context on goods transport. This holds mainly at the urban and regional level. The changing economic structure cause a shift in commodity flows and lead to new requirements to the infrastructure. Understanding of these relationships is limited, especially with respect to shippers' behaviour.
Important aspects are transport mode used, linkages between trips through logistical systems, use of warehouses, etc. International transport deserves special attention.

2. Business travel
In view of the revised priorities in transport policy in favour of commercial transport, it became clear that little is known about the nature and background of business travel. To begin with hardly any data are available on these trips. If transport policy intends to take special measures in favour of business travel, more needs to be known about the relationship between the (socio) economic structure and this type of travel.
Further economic integration of Europe will inevitable lead to a rapid growth of international and long distance trips requiring quick and comfortable means of transport.

3. Special socio-economic changes and personal travel
As was explained earlier our population is changing rapidly with respect to its age distribution. The effects on travel of the ageing of the population is not well understood because it has both direct and indirect effects. It is clear that travel by children and younger people will fail quickly. Due to demographic effects and cultural changes the labour force is growing fast. Income distribution will change due to an increasing number of multi-workers households. As a result travel patterns of the adult population will change. It is not clear what changes will occur.
The number of elderly people is increasing rapidly. It may be assumed that the future elderly people will have a travel behaviour that is very different from the present ones. They will probably possess a driver's licence and own a car, which will be used.

4. Interaction between spatial activity patterns and travel
A subject into which a lot of research has been done, but that is still not sufficiently understood is the relationship between spatial patterns of residence and employment on the one hand and travel on the other. E.g. a great deal of today's traffic problems are caused by long commuter distances. The choice of residential location by a household is influenced by the distance to work. This choice is a very complicated one since jobs may be chosen given the household's residence, there
may be more than one worker in the household, and travel and location choices are in fact highly dynamical processes with long time lags and leads. Since the theory of travel and moving behaviour is involved, this item should be discussed in the theme report on 'behaviour'.

5. Telecommunication pattern

Hardly anything is known of telecommunication patterns of firms and individuals. In order to determine whether telecommunication serves as a substitute of physical transport or contrarily, induces new travel, it is absolutely necessary to investigate volumes, geographic distribution, purpose, etc. of telecommunication contacts. Various types of telecommunication should be distinguished: telephone, telex, telematics, facsimile, etc. Personal contacts, good transport and conventional mailed messages that precede, accompany or follow such telecommunication contacts should be investigated in parallel, in order to establish the interrelationships between transport and telecommunication.

5. Emerging research directions

In this section we will mention a few research directions that came up in the recent past. They deal with new problems with respect to the socio-economic context of TCM.

a. The effect of industrial activity on transport and telecommunication

The organization of industrial production is changing rapidly; changes have to do with e.g.,
- flexible automation of production
- zero-stock principle
- different subcontracting strategies (co-makership)
- improved telecommunication facilities.

The modern production methods imply new logistical procedures with new requirements to the transport systems since it is expected that also flows of products and materials will change with respect to volume, value, frequency, distances, etc. On the long term location of plants will be affected too. Research is developing now on the complex relationship between production processes, logistics, telecommunication, freight transport and plant location choices from a public planning point of view.

b. The effect of prices on travel

In view of the limited possibilities for expanding the motorway system because of environmental and financial reasons, financial policy instruments are considered as a means to use the existing system more efficiently. By means of road pricing, charging tolls on bridges and tunnels and higher taxes on petrol together with a reduction of motor tax, it is thought that car traffic may be reduced. An item of research is how motorists will respond by changing mode or time of travel. See also theme reports on 'behaviour' and 'policy analysis'.

c. The effects of specific socio-economic changes on travel

This subject receives much attention recently. We refer for a discussion to earlier sections.

d. Telematics and regional planning

Developments in electronics technology will have a strong impact on future locational and transportation behaviour as well as decision making of firms and individuals. The effects are not well understood at
this moment so various research projects have started to analyse how travel, transport and locational behaviour of firms is affected. See theme reports on 'technological context' analysis and 'behaviour'.

6. Theoretical developments and analytical tools

In the framework of the socio-economic context analysis only theories are relevant that deal with the impacts of socio-economic factors on TCM-patterns. Most of the theories used in this kind of analysis refer either to socio-economic phenomena as such or to travel and mobility behaviour. The latter ones are extensively dealt with in the theme report on 'behaviour'.

Two theoretical developments will be mentioned here:

a. Theory of human activities
Since personal travel is derived from the activities individuals perform, travel impacts of changes in socio-economic characteristics of the population could be explained using theories of human activity patterns [15,16]. Some work has been done with respect to the scheduling of activities of household members given constraints on vehicle availability, shopping and working hours as well as the need for co-ordination between members. See theme report on 'behaviour'.

b. Urban dynamics
Although theories on urban processes encompass many more factors than socio-economic aspects, they will be touched upon briefly. A lot of empirical work on commuting, household movements etc. has been carried out in the past. Interesting theoretical advances were achieved at the Netherlands Economic Institute and the Free University of Amsterdam. A review can be found in [18].

Van den Berg et al [17] formulated a general theory of urban development, with a relationship between economic and urban development as a starting point. Decisions of households, production units and government were modelled within the utility maximization framework. They relate to migration of households and firms. The result is a typology of stages of urbanization of settlements. The dynamics of household relocation and commuting processes has been studied intensively by Verster c.s. [7] resulting in an extensive theoretical body explaining the sequence of job change, relocation or commuting.

Analytical tools that were used in analysing the effects of socio-economic context changes were - apart from the wide range of aggregate and disaggregate models - the following:

a. Cross-section and time series analyses
Many effects of socio-economical variables have been studied using cross-sectional data referring to one point in time. A main source for this kind of analysis is the National Travel Survey (OVG) held annually, among a large number of households. Households or individuals are segmented according to the socio-economic variables of interest and travel behaviour is analysed for each category. From the differences between classes the influence of certain socio-economic variables can be derived. E.g. in this way the effect of age, occupation, employment and marital status has been determined. Repeated cross-sectional analysis (time series) have been carried
out using the same data source in order to analyse changes of travel behaviour over time. These could be related to changes in the socio-economic situation at an aggregate level.

b. Panel survey
A major innovation in The Netherlands is the Dutch Mobility Panel among households. It consists of seven-day trip diaries collected in waves. Waves are collected at half-year intervals from 1984 on. This unique data enables longitudinal analysis of travel behaviour to be made. Changes in travel due to various factors can be analysed at an individual level [19,20]. (See also report on 'behaviour')

c. Quick-response models
A growing need exists for models that are able to make aggregate travel predictions within a short response time. An excellent example of such a quick-response model is the "Mobility Explorer" developed by TNO [1,2]. Using various types of elasticities and trip rates and a segmentation of the population into age and sex classes, short term predictions of the total amount of travel by mode, purpose, etc. can be made on a regional or national scale. It runs on micro-computers in a very user-friendly way and is used extensively by policy makers. It has also been successfully used to analyse the effect of socio-economic changes, like ageing of the population, income, car ownership, employment, fuel prices, etc.

7. References


17. Berg, L. van den & Klaassen, L.H. "Economic cycles, spatial cycles and transportation structures urban areas".

18. Nijkamp, P. Rina, A. & Wissen, L. van
"Spatial mobility in models for structural urban dynamics"

"A panel for longitudinal research into travel behaviour"

"The design and policy implications of a panel for studying changes in mobility over time"
Appendix-2: Theme report technological context analysis
coordinator: C.J. Ruijgrok
0. Introduction

Since the invention of the wheel developments in transport and technology have developed in close harmony. The development in population growth, urbanization and economic activities have lead to a permanent pressure to realise faster, more efficient and more reliable means of transportation. But also the reverse is true: through the fast developments in technology within and outside the transportation sector the demand of transport and mobility in general has increased permanently.

Thus technological context analysis deals with two aspects: the investigation of the possibilities of the development of new technologies to satisfy the existing demand for transport on the one hand and the determination of possible consequences of new technologies on the other.

The development of new technologies often is no matter for individual firms or individual countries. Only through the combination of forces it is possible to create a positive return on investments for large scale technological innovations. The Eureka project and the formation of multinational joint ventures reflect examples of such R&D initiatives. The result of this is that technological developments and the technological context analysis of the TCM field hardly can be reviewed on a national scale. Developments in the Netherlands will resemble developments in other European countries considerably.

In the area of technological development relevant to the TCM field one has to bear in mind that the Dutch industry, notwithstanding the strong position of the Netherlands in the field of transport since the seventeenth century, does not have a strong position in the construction of means of transport. The facilities to build railway cars have been shut down a decade ago, the only Dutch firm that has made passengers cars has been taken over by Volvo and the ship yards in the Netherlands are encountering difficult times to survive. There is an independent air and truck industry but these have to work closely together with other international firms in order to stay in competition. In communications, their is of course a very strong position of Philips but this firm is hardly to be seen as specifically Dutch in view of its multinational character.

The usage of TCM technologies in the Netherlands both for the transport of goods and information is not significantly different from that in the surrounding European countries. An exception may be the way in which some of the negative external effects of mobility have been reduced by governmental policies (especially the reduction of traffic noise).

The treatment of the technological context in this chapter will primarily deal with technological change within the transport sector itself: the development of new transport technologies and the infrastructure required. Sometimes the boundaries of the
transport system are difficult to determine. Only partially technological changes outside the TCM sector which have an impact on the transportation sector will be mentioned (developments in logistics for instance).

The text of this contribution has emerged through discussions with Dutch experts in the field of TCM technology. Because only few references exist that cover the impact of technologies on the TCM sector and that are written in the English language the decision was made to refrain from references whatsoever.
1. Important trends

In this section the trends that will be discussed have emerged in the last decade and will almost certainly continue in the next future. The most important ones that will be discussed are:
- the usage of information technology
- the increased importance of logistics
- the increased importance of the development of new infrastructure
- the reduction of external effects of transport activities

Information technology

In the last decades a strong increase in the usage of information technology in the control and automation of transport. Examples are:

a. The increased usage of information systems has led to a better control of transport processes both for freight carriers and public transport companies. In freight transport this has led to improved tracking possibilities and improved techniques for electronic transmission of data. Up till now this has especially been the case in harbours and at customs. Large carriers have developed tracking systems of their own. For smaller companies it is important that first a certain level of standardisation in communication technology have to be achieved before these investments become economically feasible.

In passenger transport the development of monitoring systems in public transport (automatic registration of passengers entering and leaving busses) and the development of sophisticated traffic monitoring systems can be mentioned. These systems enable the companies to get a better insight in the demand for public transport. They also provide tools for a more sophisticated method of allocating subsidies.

Another important field in which information technology is applied is the automation of activities that before were done by hand or through hand driven tools. The loading and unloading of trucks and vessels is increasingly done automatically using special technologies. Automatic traffic control becomes more and more demand responsive. This does not only involve traffic light at crossings but the integrated control of traffic flows on intercity networks and freeways. Starting at the freeway from Rotterdam to the Hague a number of busy sections of freeways has been equipped with extensive traffic control technology developed by Philips.

The increased usage of means of telecommunication has led to the possibility of remote control. On central units information from distant locations is brought together, processed and transmitted in order to control transport processes both in freight and passenger transport. Up till now there still exists a strong relationship between the physical location of transport and
production facilities and the locations where the information concerning these processes is brought together.

b. Logistics
For the freight sector in particular the increased awareness of the importance of logistics and the logistical organisation has had an important influence on the the transport function. In integral logistics production and transport are considered as equally important to achieve the goals of a reliable and flexible logistical operation through all elements of the logistical chain. On the basis of integral cost calculations optimal configurations are chosen that are not necessarily identical to the result of partially optimised systems. As a result of this shippers and carriers are trying to increase their span of control and are forming organisational structures to increase the vertical integration of production and distribution. As a consequence the importance of "external logistics" has increased. Logistics is not restricted to activities that only relate to divisions within a company but increasingly affects the relationships between companies.

For the TCM sector this has led to an increase in the amount of logistical data interchange and also to changes in the volumes and the technical characteristics of transport. The globalisation of production has led to increased transport quantities and the tendency towards flexibilisation and increased reliability has led to the increased usage of faster, smaller and more expensive means of transport. The usage of express parcel services and air cargo has increased considerably. The modal shares of rail and inland navigation have fallen down except for the transportation of containers on large distances. Technological solutions are sought for to increase the level of reliability (informatisation and automation) that is an essential prerequisite to achieve smooth flows through the logistical chains.
Examples are:
- The development of demountables (SWAP bodies) that can be used in intermodal transport and serve as temporary storage facility. They have the advantage above containers that, used on a truck no external lift-on and lift-off equipment is necessary.
- the usage of roll on and roll off techniques for loading and unloading of vehicles. Thus a truck becomes a part of a conveyer band that moves from one factory to another.
- The design of high volume trucks that, within the legal limits, can transport big quantities of low weight products at low cost.
- The installation of on board computers that facilitate the task of the driver, improve the communication between the truck and the main office and can perform administrative tasks that otherwise would lead to delays or mistakes.

c. Infrastructure

A third major trend which has emerged more recently partly as a consequence of the developments mentioned under b. is related to the increased attention for high quality infrastructure. The accessibility of economic centers is endangered through the
increased mobility. The satisfaction of the demand for transport and the achievement of the required level of reliability can only be fulfilled through large investments in road and rail infrastructure in order to solve present and expected bottlenecks. The discussion regarding ‘Missing Links’ by European industrialists and European networks for high speed trains indicate that these issues not only are topical in the Netherlands. Large scale infrastructural projects ask for a reevaluation of existing technologies. High speed trains ask for advanced technologies to overcome the problems of the non standardised European railway networks or even completely new technologies (Maglev).

In designing new car infrastructure new technologies emerge to increase the level of safety and increase the capacity (Prometheus). In the Netherlands these developments are followed with great interest but have not yet led to large study projects regarding the economic feasibility of such new technological concepts.

Although in principle the improvements in the quality of infrastructure could lead to an increase in the capacity of roads, waterways and railway tracks, most of the innovations implemented up till now primarily serve other objectives like improving safety or reduction of costs for maintenance.

d. External effects

A fourth major trend deals with the reduction of negative external effects of the car traffic. Technological instruments have been developed to:
- improve the air quality through a reduction of the emission of toxic gasses.
- to reduce noise nuisance, energy usage and production of waste materials.
- to improve traffic safety.

In the past decades an important part of the negative external effects of car traffic have been reduced. The present level of moisture and unsafety is by far not satisfactory and additional measures will be necessary in the near future, also in anticipation to the expected rise in car mobility. Examples of these technologies include:
- adaptation of vehicle construction and motor technology (mass reduction, reduction of energy usage, fuel substitution, reduction of air pollution, introduction of new materials);
- changes in road conditions (speed limitation, ramp metering);
- changing travel behaviour (information, rules).

At present there is a discussion going on whether the improvement of car technology will perform enough reduction in air pollution to achieve the required levels that are necessary to solve the severe threats of accident. Unless new and improved technologies will be developed it might be necessary to implement policies to reduce the level of mobility.
2. Research issues

The research issues that presently get or deserve attention are closely related to the trends mentioned in paragraph 1. The consequences of the technological developments onto the TCM sector are not very well understood yet and a considerable research effort is necessary to get a better insight and to guarantee an adequate allocation of funds for these technologies. It is felt that research effort is especially necessary in the following areas:

a. Research regarding the effects of increased application of informatics on the future developments in freight and passenger transport on the demand and realisation of transport flows. It is not certain whether the application of informatics will lead to a substitution or to a generation of traffic. Telematics, teleworking and teleshopping seem each to have possibilities to substitute physical trips or transports. However the intensification of the communication possibilities will create a new demand by itself. Also in freight transport this tendency can be observed: the application of “just-in-time” technologies leads to an increased number of messages to be exchanged between logistical partners. At the same time it leads to a reduction in shipment sizes and towards a shift in trade offs between transport and inventory costs, thus leading to an increase in the number of shipments. Whether or not this increase of informatics will lead to a concentration or deconcentration of functions and to a disentanglement between information flows and physical flows is not certain.

b. The consequences of the changing logistical organisation on the infrastructural requirements and the transport equipment necessary requires further attention. Research in this area could regard:
   - the possibilities to optimize the utilisation of vehicles (reduction in the number of empty trips, more efficient route planning);
   - the consequences of logistical changes on the location of production and distribution centres (one could expect concentration as well as deconcentration tendencies);
   - the consequences of global logistical changes on the shifts in transport flows, the way of appearance of these flows and the usage of different forms of transport).
   - the insight in the consequences of a non existence of high quality infrastructure and the problems to cross borders on the logistical organisation of firms. This will facilitate the possibilities to foresee the consequences of the removal of bottle necks and border problems. Calculations have been made regarding the losses that are suffered by Dutch transporters waiting at European borders. Although these figures are quite impressive (more then 1 million dollars each year) it might be expected that other logistical costs (extra inventory costs, communication costs) will exceed these waiting costs considerably.
c. This last point directly leads to a following emerging research issue: that of the financing of new infrastructure. Apart from the financial economic issues involved here an important technological issue is the exploration of the possibilities to collect funds from the users of this infrastructure according to their level of usage or according to the external effects they produce for others. Theoretically systems of road pricing on individual basis are already feasible. The solution of all kinds of technical problems and the resistance towards the danger of "big brother" developments obstructs the practical application of these concepts. Further research could indicate whether these problems can be solved. Other research areas related to the construction of new infrastructure are:
- the investigation of the attractiveness of the design of specific infrastructure for trucks (freight lanes);
- the possibilities to devide long distance and short distance traffic;
- the potential application of new technologies to achieve a higher level of traffic safety (automated highway)

d. The reduction of external effects of the car traffic leads to the need to have an insight in the effectivity of the instruments available to reduce this effects and make a cost benefit analysis possible. Extensive programs to reduce these negative external effects have already been developed. Technological developments alone seem to be insufficient to achieve the desired level of reduction of these problems. Therefore the trade off between additional technological investments and instruments that are aimed to reduce the level of mobility itself will emerge.
3. Gaps in knowledge

In order to be able to give adequate answers to the research issues mentioned before it is necessary that enough knowledge exists regarding the functioning of the TCM-system and the way this system will react on new developments such as the implementation of transport policies and the introduction of new technologies. At present the tools to elaborate such an evaluation seem rather limited. Especially on the following areas an extension of our present knowledge is required:

- Insight in the behaviour of firms regarding the way they will change their logistical organisation using the emerging technologies to make integral logistical control feasible. At this moment a good insight in the present logistical organisation is lacking; let alone that such views on the future situation exist.
- Insight in the way users of infrastructure (public transport travellers as well as users of car infrastructure) will change their travel behaviour due to new technological concepts. Apart from the impact of telematics the willingness of individuals to rely upon artificial intelligence is at stake here.
- Insight is missing in the way advanced information systems will influence the possibilities to achieve a more efficient transport system. Such an insight is necessary to determine the required level of infrastructural investments and to make cost-benefit analysis regarding the implementation of such systems.

In general, technology assessment in the TCM field is as yet not well developed in the Netherlands. This holds true for the implementation of new technologies within firms as well as the implementation of new technologies in constructing infrastructure.
4. Emerging research directions

For some of the subjects mentioned above extensive R&D efforts are being carried out already, as well in industry as at universities and governmental institutions. The impression exists, especially in the area of infrastructure research not enough combined effort in creation of research opportunities has been achieved. The cooperation and coordination of research efforts in this area should improve. Also the tools to perform this research challenge in order to make a well balanced consideration of policy strategies regarding new technologies need improvement.

Especially in the field of freight transport there is an urgent need for data to give a better idea of the consequences of the introduction of new technologies.

Summarising, the most important areas of research lay in:
- research regarding the consequences of the extended application of informatics on the logistical organisation,
- research regarding the consequences of changes in the demand for transport and changes in the technological possibilities on the utilisation of infrastructure and the available means of transport.

Internationally there exists a need to achieve coordination, standardisation and harmonisation regarding infrastructure components, electronic data interchange and design concepts of vehicles. Such harmonisation is an essential prerequisite to achieve cooperation on an European level on each of these areas. Especially in the area of information systems such cooperation is strongly needed. Also in developing supranational infrastructure projects such cooperation is essential to be able to avoid duplication and unnecessary competition.

At this moment there exist a Dutch participation in the FAST program of the European community and also in the COST projects a limited Dutch participation exists. The COST 306 project on the feasibility of standards for logistic information exchange is such an example. The focus of most of these research projects is on technological developments "sec", and not on the possible consequences of applying these technologies. This area needs further attention.
5. Theoretical Developments

In the area of technological context analysis there has not been a unified approach regarding the research methodologies used. Also the theoretical basis for this type of research is not very well developed.

In addressing the future scope for theoretical developments a distinction can be made between research methodologies that are aimed for solving a particular technological problem and research methodologies that are necessary to evaluate the feasibility or the consequences of new technologies.

Into the first category can be placed:
- Studies regarding the possibilities of applying optimisation strategies in passenger and freight transport. Especially the improvement of procedures and techniques for optimizing personnel and transport equipment can be mentioned here.
- Improvement of technological concepts at the design of vehicles, infrastructure, traffic control, avoiding negative external effects.

Into the second category fall:
- Methods to evaluate the consequences of applying new technologies. Especially the lack of sufficient and reliable data on firm behaviour is an prerequisite to improve existing techniques.
- Methods for carrying out before and after surveys or technology assessments for determining the effectiveness of new technological concepts.
Appendix-3: Theme report behavioural analysis  
coordinator: P.H.L. Bovy
Introduction

This part of the review of TCM-research in the Netherlands deals with the behavioural aspects of transportation, communication and mobility. Behaviour refers to the decisions of individual agents on the transportation market and related areas. These agents are individual persons, households, firms, etc making demand or supply decisions. The behaviour of the government as an actor in the transportation market, mainly on the supply side, is not considered here and is treated separately in the review part on 'policy'.

The notion of 'transportation market' is taken fairly broadly. It consists in the first place of all forms of physical movement of persons, goods, and vehicles. However, also communication contacts, that is the exchange of messages and information between remote actors, such as by telephone, are included because of the apparent relationships with transportation. Finally, so-called mobility decisions are dealt with. These refer mainly to the locational decisions of households and firms, especially with respect to the relationship with transportation factors.

The report first presents, in a very concise way, the main trends in behaviour in the TCM-field in the Netherlands that can be distinguished in the last two decades, followed by the main research issues that were tackled in that period. Important gaps in behavioural knowledge are identified against the background of current and future needs. Then some major behavioural research directions emerging in recent years are listed. Finally, a brief summary is given of theoretical approaches and analytical tools that were typical for Dutch behavioural research in the past twenty years.
Trends in behavioural patterns

2.1 Megatrends in transportation

2.1.1 Demand

Typical aspects of the Netherlands which affect the travel behaviour of its residents are the relatively high population density and the high proportion of the population living in cities. This is one of the causes among other things of the intensive use of the bicycle in the Netherlands and the relatively dense public transport system.

One of the overwhelming trends in transportation of the last two decades is the strong increase in personal travel mobility. This trend is in fact a continuation of a development that started already decades before. The causes of this development are manifold and are shared with the other affluent modern countries. It is generally agreed that rising net incomes form one of the reasons for this development. This rising income led among other things to rising personal car ownership. The availability of a car enabled households to get more easily to their preferred dwelling locations in suburban or rural environments, the result of this process being increased distances between activity places such as home and work.

These three interrelated and mutually dependent factors (income, car ownership, distant locations) together form the main forces of the still growing travel demand of individuals.

A growing number of persons and households decided to spend an important part of their income on mobility through the acquisition of a car and subsequently to run their car in producing their own transport services. This behavioural trend, that started three or more decades ago, resulted in a three-fold increase in personal car ownership per thousand inhabitants from 104 in 1965 to 340 in 1985. At the household level car ownership increased from 333 to 888 cars per thousand households. The diminishing growth rate of personal and household car ownership in the last years indicates a development towards saturation.

Especially car owners were able to enlarge there activity space accordingly: personal car mobility expressed in travelled kilometres per person per year by car grew from 3,300 km in 1965 to 7,900 in 1985. In the same period, due to this rising car mobility, total personal mobility increased as well but at a much lower rate, due to substitution effects among other things. Total travelled kilometres per person per year grew from 6,800 km in 1965 to 10,400 in 1985, which comes fully at the account of the car. The share of the car in total personal mobility rose from less then 50% to nearly 80% in 1985. The larger increase in personal car mobility compared to total travelled kilometres indicates that growing car ownership partly resulted in substitution of other modes but to a much larger extent it generated new mobility.
The personal mobility of the carless people however increased as well due to rising incomes and growing distances between activity places.

The rise of the car and the increased distances led to a significant drop in bicycle use. The former predominant position of the bicycle, e.g. as the main mode for work trips, is now occupied by the car. This is a major cause for congestion in city centres.

The increase in mobility is not evenly distributed among categories. First of all, the increase is largest with persons having got access to a car. Second, travel mobility increased dominantly at intercity relations, to a large degree determined by past migration processes. Also international travel strongly increased. On the one hand, the steady development of a stronger international economic and commercial integration on a European and global scale induces a growth in international business travel. On the other hand, rising incomes enable persons to make more international trips for recreational purposes. The international travellers showed an increasing preference for using the aeroplane for their trips giving rise to a considerable increase in personal air travel.

With respect to the demand for goods transport there is a clear trend to ship the goods by using the faster modes: this means more transport by truck or aeroplane and less by ship or train. The reasons for this change in mode choice is first of all the change in the type and value of goods which reflects changes in the economy as well as in the production process of the goods (specialization, co-makership, just-in-time production etc.). In addition, changes in the supply characteristics of the various modes play a role, such as larger improvements in costs, travel times, and reliability in air and road transport compared to water and railway.

With respect to road goods transport, a change in truck types and sizes can be observed in the last two decades. Fleet owners prefer to use the smaller and the larger sizes at the cost of the medium sized trucks. This change in behaviour also may be induced by the change in type of goods to be transported. On the other hand, it may be caused by developments in truck technology and transport logistics.

2.1.2 Supply

An overwhelming trend on the supply side of personal travel is the governmental intervention in the supply of public transport services (see e.g. [8]). First of all, despite the large deficits of all public transport operators the government decided that services had to be maintained at a socially acceptable level with respect to spatial coverage and frequencies. This was enabled by subsidizing the public transport suppliers. Secondly, the government determined the prices of the services (fares) at a socially
desirable low level in order to maintain these affordable to the captive riders and to keep this mode attractive compared to the other modes. In some instances however, services were abandoned and frequencies diminished in order to decrease operating costs. For the average train traveler this means that the fare of his trip only covers half of the trip cost; for the average local public transport user this difference is even larger: he pays only a quarter of the real trip cost.

In the last two decades public transport operators tried to encourage public transport use by offering a variety of special fares for special market segments. An example of these are the special fares for the elderly.

With respect to road transport the government diminished the yearly investments in roads by more than a factor two in the last two decades; despite this the road network expanded and improved its performance in terms of accessibility, travel time and safety. An exception was made for bicycle traffic: special investment programs were aimed at increasing the size and quality of the bicycle network within and outside of cities.

On the other hand, in order to limit the negative effects of car travel, especially environmental effects, the government imposed a couple of extra taxes to the car user through higher taxation of new cars, higher taxation of gasoline, and the like. The price of car travel increased significantly but this was compensated by rising incomes to a large extent.

In the goods transport sector an improved supply was achieved through private investments in technology and logistics improvements (containerization, unification, standardization, etc). Road transport could improve its efficiency relative to ships and railways due to improved performance of road networks and improved efficiency of vehicles.

2.2 Megatrends in communication

2.2.1 Demand

The last two decades have shown a strong increase in demand for almost all forms of telecommunication. Overall, the rate of increase is more than a factor two. It is an expression of the development of the communication society.

The penetration of telephone connections in private households and firms is now near 100%. Household income is no longer prohibitive for having a telephone. In addition, the car telephone is penetrating strongly in the market of business persons. The use of the telephone for private and business purposes has tripled in the last twenty years. The use of modern communication techniques such as telex and telefax grew at a much faster rate: telex-minutes increased for example by a factor five. To a cer-
tain degree telephone calls have become a substitute for other forms of communication including postal and physical contacts; on the other hand there has been a considerable amount of newly generated contacts because of the widespread availability and easy handling.

Telephone contacts enabled people to enlarge their geographical contact field considerably: whereas local calls increased by a factor two-and-a-half, long distance calls grew by a factor four and international calls even by a factor twelve.

Notwithstanding the substitution of postal contacts by telephone, postal messages yet increased in the same period by a factor two, the increase being much larger for business than for private purposes. It is supposed that also in this case there is partly a substitution effect and a generation effect.

In general, communication for business purposes increased much faster than for private reasons.

Another feature of the growth in communication is the stronger international orientation: international telephone contacts increased by a factor twelve.

One of the components of the increase in telephone contacts is certainly the increase in data communication between computers.

The widespread increase in telecommunication certainly follows from the supply of all kinds of services offered by private and governmental institutions.

In summary, the trends in demand for communication can be characterized by:
- more frequent contacts;
- stronger preference for more direct and quicker communication techniques;
- interaction over longer distances, both within and between countries.

2.2.2 Supply

Actors on the supply side of communication were very active during the last two decades. Especially telecommunication services were improved dramatically through huge investments in networks and in exchange stations on earth and in space (satellites). These investments resulted in new services (e.g. car telephone, data transmission) as well as improved quality of existing services. The private industry supplied the market with many new forms of devices and equipment (e.g. modems, telefax, etc.).
A significant trend with respect to mobility decisions is the decision of households to move out of larger cities. In the past twenty years large streams of migrants left their original residential areas and settled in suburban and rural environments (see e.g. [9]). The choice for a new residential location was mainly influenced by shortages in housing supply in the traditional cities on the one hand and the newly created housing supply on the other hand. Also preferences of the households for particular types of residential environment played a role in this movement. In general, considerations of housing quality had a much larger influence on the decision to move than distance to work.

The development of new residential areas, partly in the form of new cities (Almere, Lelystad) as well as so-called growth-cities (e.g. Breda) and growth-centres (e.g. Alkmaar), for a large part was the result of governmental policy as a response to the bad housing market situation in existing cities in the sixties. For many migrants, the decision to move was facilitated by the availability of a car with which the increased distances to work could be managed. The carless group of them however experienced a strong decline in travel opportunities in many cases many of them responding to this drop in mobility by acquiring a car. This home-induced migration of households as a consequence resulted in increased commuting distances of workers to their traditional working places: commuting as a complementary action to migration.

A second trend is the choice of working location farther away from home without subsequent change of the residential location (see e.g. [31]). Also here various forces are at work. On the one hand, there are developments in the structure of employment (more specialization, etc) and the bad situation on the housing market that lead to growing distances between supply of and demand for jobs. On the other hand, improved travel conditions among other things through increased car ownership facilitate workers to accept jobs at larger distances from home. Also in this case larger commuting distances are the result: this work-induced commuting is taken as a substitute for migration.

A recent trend similar in characteristics but starting later than the migration of households is the movement of firms and offices out of the central cities (see e.g. [9]). There is an increase in suburban office location choice due to lack of space at inner-city locations and better accessibility of the firm at the suburban places. In many cases this better accessibility is meant in terms of car access. Also this office migration in general leads to increasing home-to-work distances for employees, and to shifts in modal choice in favor of the car.
2.3.2 Supply

An important decision on the supply side was a governmental act to support the establishment of new cities as well as the enforced development of growth-cities (see e.g. [9]). This was meant as an instrument to capture the growing demand for housing and lack of adequate housing stock in the large conurbations, as well as to achieve a more balanced population density among other things. Essential was the assignment of such cities at locations distant from the large conurbations where the majority of employment can be found. This planning principle resulted in growing commuting distances for those who moved to the new or expanded cities.

In the free market a significant trend in the preceding decades was the establishment of large shopping centers at suburban locations that are easily accessible for the car. Reasons for this development are closely bound up with, on the one hand, serious disadvantages at the traditional locations in city centres, such as lack of expansion opportunities and poor accessibility because of traffic and parking congestion. On the other hand, suburban sites offer many advantages with respect to freedom of spatial and architectural design, the supply of a well-balanced package of shops and goods, transport accessibility for both clients and deliverancies.

Another trend relevant from a transportation point of view are the many agglomeration and spatial concentration actions with respect to public services such as schools, hospitals, etc. These decisions, motivated mainly by efficiency considerations, generally led to increasing distances for users of these services.

2.4 Summary

In summary, on the demand side, the last two decades show an enormous increase in interaction distances both in physical travel as for communication. This increase is partly enforced as a consequence of supply decisions. However, for the most part, this increase is due to the consumers’ possibilities to spend more time and money for travelling and telecommunication as well as to a general increase in travel and communication opportunities.

There is a shift towards more use of quick and easy modes such as the car, plane and telephone.

International contacts increased strongly, especially for business purposes and goods transport, a major reason of which is the stronger economic cooperation in Europe.

On the supply side, governmental intervention in public transport, especially in the form of sharply increasing subsidies is noteworthy for the last twenty years. On the other hand, government spending in road investments declined systematically.
Location decisions generally were car-oriented and lead to increasing travel distances.
3 Research issues in behavioural research

3.1 Transport

3.1.1 Demand

The most important issue in the field of transportation demand in the last two decades was **mode choice** for personal travel. Especially the choice between car and public transport was dealt with.

The mode choice situation in The Netherlands is more complex than elsewhere because of the important role of the bicycle, especially in cities.

This issue mainly originated from the following two developments. On the one hand, there was the recognition of the negative impacts of the strongly growing car use for society, such as traffic congestion in city centres and on freeways, environmental effects (noise, air pollution), fuel consumption, etc. On the other hand, there was a stagnation in public transport use accompanied by serious financial deficits of public transport companies and authorities.

Research into mode choice and mode usage was aimed at finding insights into personal travel behaviour that could help in developing and testing policy instruments and plans directed at diminishing (the increase in) car use and increasing the use of public transport and the bicycle.

The issue of mode choice first came up at the local and regional level, especially in the larger conurbations. In addition to the general question of choice between car and public transport also car parking behaviour and bicycle use were part of the problem here. At the interregional level the mode choice issue mainly is confined to car and train. Recently, mode choice for international travel has become a research subject as well. This is induced by the development of a European network of high speed trains. At this level, the air plane is included in the mode choice problem.

With respect to mode choice behaviour, the predominant research issue concerned measuring preferences for modes and mode attributes (see e.g. [32]). These preferences mostly are expressed as direct and cross-elasticities of demand dimensions (choice, number of trips, kilometrage) with respect to various mode characteristics (mode availability, fares, prices, travel times, comfort, etc.). In this respect, the value-of-travel-time is one of the mostly derived parameters to characterize mode choice behaviour.

Also, choice constraints became an important item in mode choice research (see e.g. [15,33]). It was recognized that the potential efficacy of policy measures is strongly dependent on the level of freedom of choice within the target population. The identification of choice constraints and types of mode captivity (mode availability, travel constraints, personal constraints, etc.) should enable the estimation of the market of free-choice travellers that
are potentially sensitive to changing travel conditions. In addition, this gives clues regarding policy instruments that can diminish constraints so that this market may increase in size. Subjective attitudes of travellers with respect to modes and mode attributes was also a major subject within the broader issue of mode choice research (see e.g. [26]).

General findings from the past research are among others:
- mode captivity is considerable, in many instances more than half of the travellers is constrained to a particular mode for their trip [13,15];
- travellers are not very sensitive to prices (or money costs);
- non-measurable, mode-specific attributes play an important role in mode preferences.

For a general overview of Dutch research see e.g. [1].

Within the general subject of choice between modes, a number of more specific research issues have been dealt with in the past of which car ownership, parking in city centres, and public transport quality were the major subjects.

Much attention has been paid to car ownership and car use. The recognition that car availability is the major force behind car use led to studying the questions which factors contribute to the acquisition of (or the disposition of) cars by households (see e.g. [11]). Many studies have been carried out into the effects of household variables (income, composition, age, etc), location variables (proximity to public transport stops), prices of car use (acquisition, possession, operation, fuel), etc upon the ownership and usage of cars. Also the assignment of a household’s car to a particular trip of a household member was subject of investigation [12]. Special attention was devoted to the contribution of policy instruments influencing costs of car ownership and car use such as various taxing procedures and cost allowances by employers [2,11].

Apart from studies into fare elasticities with respect to public transport demand, much research effort has been devoted to the effects of access and egress to stops and stations as well as to transfers (see e.g. [14]). From these studies it has been learned, among other things, that the egress (non-home) trip-leg is much more important than the access-trip-leg at the home side of the traveller (because of the nearly full bicycle ownership). This means e.g. that public transport use for work trips can be significantly encouraged by locating major employment concentrations at public transport network nodes.

For trips within cities and regions, the bicycle is a major mode in The Netherlands (mode share of 40%) and is a strong competitor for public transport and the car. Much effort has been spent to find out how the bicycle system can be improved in order to consolidate or even strengthen the position of the bicycle relative to the other modes (see e.g. [25]). It was found among other
things that direct connections and a high network density are much more effective in stimulating bike use than concentrating investments in few, high-quality facilities.

3.1.2 Supply

A major supply-oriented research issue in the past twenty years was pricing. Initiated by the government, a lot of studies have been carried out into the effects of prices upon various elements of travel demand (car ownership, number of trips and kilometrage by mode, time of the day, etc). Through taxation and other legal measures the government influences the prices of car acquisition, car ownership, and car operation (fuel costs). Also through road tolls and parking charges the price of car use are influenced. On the other side, the government nowadays determines the level of fares, the fare structure, and all kinds of special prices for public transport services. Real travel prices also depend on travel cost allowances that e.g. may be offered by employers. Much research has been done into the feasibility and efficiency of various kinds of price instruments (mainly taxation and fares) to achieve a desired (re)distribution of personal travel demand among modes (see e.g. [2]). More recently, price instruments, among others road pricing, have been studied aimed at achieving a desired redistribution of travel demand over periods of the day (peak shaving), routes in the car network, types of transit services, etc.

A second major area of research was the development and testing of new public transport services. These services include dial-a-ride systems in rural, low-density regions, and para-transit for the elderly and handicapped in cities.

Only recently, the potential effects of telematics upon the transport and communication behaviour of individuals and firms has become a major research issue. Main interest is in the effect of the introduction of all kinds of telecommunication services (teleshopping, telebanking, teleworking, etc) upon the level of physical transport (for an overview see [16]).

3.2 Mobility and location

A major issue in mobility research of the last two decades is the household’s choice of residential location. Especially interurban migration received much attention because of its severe transportation consequences (commuting). The interest in housing location choice partly resulted from the negative effects of the urbanization process in the large conurbations. On the other hand, insights in this choice behaviour were needed in formulating policies with respect to achieving a desired regional population distribution (new towns, growth-towns, compact-city-idea). Research questions concerned the effects of household variables (income, age, life cycle, car ownership, etc), accessibility
variables (distance, travel time), and location variables (e.g. housing quality) upon the decision to change the housing location. Of special concern was the change in commuting distances (see e.g. [31]).

The housing location choice appeared to be dominated by the quality of the house and the residential environment, while the interregional movements were very selective with respect to household characteristics (income, job types, car ownership, etc).

Also the location and movement behaviour of firms and offices was a major research issue (see e.g. [34]). Investigations were carried out into the reasons of firms to leave central city locations and to settle at suburban locations. One of the research questions was the influence of accessibility upon these decisions. Also the effect of the locational change upon the travel behaviour of the employees received much attention.
4 Gaps in behavioural knowledge

4.1 General

With respect to gaps two viewpoints may be distinguished:
- Gaps in knowledge for policy purposes: lack of knowledge on behavioural responses that is urgently needed for decision making in transportation and location planning of governments and in the private sector; this knowledge is needed for predictive and evaluative purposes;
- Gaps in knowledge with respect to scientific purposes: knowledge is needed in the course of theory development on transportation related phenomena; knowledge has an explanatory function.

Below, a number of topics are described mainly reflecting actual information needs for policy purposes.

4.2 Transport

4.2.1 Demand

a. Congestion effects on behaviour

Congestion in overloaded networks (freeways, public transport, parking in cities) has become a widespread phenomenon in large parts of the country, especially during morning and evening peaks. It is important to know how the decrease in travel quality (losses in travel time and comfort, increased costs, unsafety and unreliability, etc) influences generation, mode choice, time choice, route choice, etc of potential travellers and goods shippers. The same applies to the effects of toll charges levied in congested situations. Especially, the distributional effects with respect to the type of travellers and transport being harmed are relevant. In addition to the direct responses of actors through changed travel decisions also the impact on second-level mobility and location decisions, such as with respect to jobs, education, etc are important.

b. Positive effects of mobility increase

In the past much transportation research was undertaken as a response to the negative effects of growing car use (congestion, environmental deterioration, etc) and was therefore often directed at limiting the increase in mobility. The benefits of good transportation opportunities and travel quality to the population are widely neglected as a research subject. It is necessary to know more about the positive effects for individual actors that can be gained by a higher mobility level, such as: better accessibility to (better) jobs, better accessibility to education, increased household income, improved opportunities to sell products, etc.

c. Car acquisition process
Car ownership is a key variable in travel decisions. Despite twenty years of research into car acquisition changes in car ownership appear difficult to predict. Continuous changes in household types and structure, life styles, etc as well as in car supply (types, technology, etc) among other things demand for continuing research efforts. Also insights derived in a period of steadily improving conditions with respect to income, traffic, etc may not be valid in times of decline. Relevant questions with respect to car ownership are among others the moment of (first and second) car acquisition relative to other household state variables, the effects of job and locational changes in the household upon acquisition decisions, the effects of improvements in car technology (driving, noise, fueling, telephone, etc) upon car ownership in hitherto carless population segments.

d. Personal travel demand for business and commercial purposes

In order to gain better insights into the significance of good travel conditions for the economy more research is needed into the characteristics of personal travel for business and commercial purposes. Relevant questions are among others: mode choice (value-of-time, effect of time reliability, effect of congestion), substitution with telecommunication, timing, mileages.

e. Goods transportation demand

There is a need for a theory about the goods transportation process leading to predictive models for goods movements and consequently goods transporting vehicle movements. The theory should be able to predict effects of changes in production structure, with respect to type of intermediate and final goods as well as location of firms. Especially the shippers' mode choice behaviour should be given attention. This theory will be much more complex than in the case of personal travel demand: there are many more different agents involved with their own preferences: final consumers, intermediate consumers, shippers, carriers, producers.

f. Individual tastes and preferences.

There exist differences in individual preferences within the population of travellers. In the past, almost no account was made of this variation (models were population averages), leading to aggregation biases and thus false interpretations and predictions. Current explanatory and predictive demand models try to capture this variation to a certain degree by market segmentation: this will lead to better demand estimates as well as better indications about useful policy measures. This market segmentation should however be based on knowledge of the variation in individual parameter values. There is a need for the derivation and establishment of truly individual demand functions in order to learn about the extent and level of differences in individual preferences. Demand
theories at the level of the individual are available but there is a lack of individual data and statistical estimation techniques necessary for deriving individual preference parameters.

4.2.2 Supply

In view of the increasing congestion in the road system, research is needed into the feasibility and efficacy of pricing strategies such as tolls, to control the use of the road infrastructure. These road pricing strategies aim at establishing the cost of travel in the network to the individual user in such a way that an optimal distribution of network use in time and space (network parts) is achieved. On the one hand, the supply characteristics of pricing measures should be studied: type of toll, timing of charging, which traveller groups to charge, etc. On the other hand, the intended and external effects on the demand needs to be investigated (captive users, mode, route and time changes, etc). Also, higher level response (relocation of activities) is of concern.

4.3 Communication

The era has already started where telecommunication has become a serious competitor of physical transport. Research is needed into the characteristics of new telecommunication services and their effects upon the interaction and location/mobility behaviour of individuals and firms. Relevant questions are among others:
- acquisition of telecom equipment in the household and firm, and its use;
- changes in activity pattern;
- changes in telecommunication and travel habits: substitution and generation effects with respect to interaction frequency, modal choice, time choice, etc.;
- changes in residential location.
Especially, the response of business firms on telecommunication services with respect to personal travel, goods transport, and at a higher level, on locational choices, needs investigation.

On the supply side, research is needed into the possibilities that telematics offers to improve travel conditions and hence capacities, e.g. through route guidance, early warning systems, etc.

4.4 Location and mobility

There is a general lack of knowledge into the locational choice behaviour of firms. On the one hand, transportation related variables may affect these decisions to a large extent; on the other hand, the outcome of these decisions exert a great influence upon the travel pattern of employees and clients, as well as on the distribution of goods. Apart from physical accessibility, also
access to the telecommunication network has recently become a re-
levant location factor to investigate.
5 Emerging research directions

5.1 Introduction

The research directions that emerged in recent years partly developed out of old problems where still gaps in knowledge exist (e.g. effects of congestion) and partly originate from changes in the socio-economic context (e.g. household characteristics, tele­

Ongoing research already mentioned as ‘gaps’ (see 4) concerns among others:
- effects of congestion upon travel, mobility, and locational behaviour;
- determinants of car ownership;
- effects of new telecommunication services upon travel and locational behaviour.

5.2 Transport

5.2.1 Demand

Stimulated by the recent economic recession projects have been initiated into the effects of a decline in socio-economic conditions of households and individuals (such as getting unemployed, income decline, decreasing car ownership) upon their travel behaviour (number of trips, mode choice, travel expenditure, mileage travelled, etc) (see e.g. [11]). In a more general sense, various rapidly changing socio-economic conditions such as:
- in the household’s or individual’s employment status (retirement, unemployed, working participation of women, number of wage earners, etc);
- in working times (flexi times, shortening of working time, etc.);
- in household size and structure (increasing number of singles, divorced, one-parent households, etc);
- in household income, are studied with respect to their effects upon mobility (car ownership, residential location) and travel decisions.

Despite the strong decline in interurban migration in recent years, interurban commuting is still growing. In order to identify the various causes of this process new research projects have been initiated recently.

In the past much of the research stressed the spatial component of transport. It has been recognized however that many of the problems are caused by the time component inherently attached with travel decisions. A lot of research has been started in recent years into time decision making of households and individuals (see e.g. [5]). An important part of these studies deals with daily and weekly activity scheduling and investigates actual or potential responses (changes in timing or even rescheduling of...
activity patterns) to increasing road congestion, introduction of congestion tolls, diminishing or improving public transport services, changes in household characteristics (e.g. employment).

Along with the interest in behavioural responses to changed conditions there is a growing need for research techniques enabling the analysis of dynamics in behaviour. Such techniques are being developed in the course of the national longitudinal transportation panel survey.

*Long distance and international travel* has become more important during the last decades. New services such as high speed trains have been developed to meet this demand. A lot of studies have been initiated to get a better insight into the characteristics of this market segment (see e.g. [19]). The potential effects of new rail lines for long distance travel and of high speed rail services upon choice behaviour of this category of travellers are subject of these studies.

With respect to goods transport an increased interest of researchers concerns the effects of improved logistics management of the goods distribution process upon transport decisions of shippers and carriers.

5.2.2 Supply

On the supply side a continuing stream of research deals with developing and testing of pricing strategies aimed at controlling the demand for road transport and partly as a means of financing investments in roads. Recently, special attention is given to the feasibility and efficacy of road tolls as an instrument to tackle road congestion and to achieve a better distribution of road transport demand among network segments and periods of the day.

Also the development of new public transport services receives attention. Noteworthy here are the studies dealing with the connection of The Netherlands to the European network of high speed rail lines.

5.3 Communication

A fastly growing body of recent research deals with the relationship between telematics and TCM.

On the supply side, studies deal with the location, configuration and implementation of high-level telecommunication networks in cities (Amsterdam, Rotterdam) and at the national scale (see e.g. [30]). Many demand studies are underway investigating the demand for telematic services for individuals, households and firms, and possible substitution effects between communication and physical transport both for personal and goods transport (see e.g. [16]).
5.4 Location and mobility

The location choice behaviour of firms and offices attracts an increased attention in recent years. From a transportation point-of-view questions are dealt with such as effects of:
- introduction of telematics;
- road congestion;
- new rail lines,
upon locational choice and upon spatial concentration/deconcentration of business activities.
6 Theoretical developments

6.1 Transport Demand

In the past two decades most attention has been paid to the theory of modal choice and related subjects such as car availability. Also route choice theory in road and public transport networks attracted much effort of Dutch researchers. Characteristic for theory development in the past was among others the recognition of travel as a derived demand and travel as the result of individual decision making.

Most progress was achieved through development and application of random-utility discrete-choice theory for separate and linked travel choices. In the course of this theory development, ample attention was given to the development of notions like individual choice set (set of choice alternatives available to the individual traveller), captivity (no choice options, only one alternative available), preference functions/trade off functions/utility functions representing the way individuals evaluate attributes of alternatives.

Theory development for a large part was based on already existing, more general knowledge about decision making (from the field of psychology) and micro-economic behaviour. Application to the transportation field was enabled by the development of statistical estimation techniques and high-speed computers.

Earliest steps in the development [e.g. 17, 18] involved considering trips as independent choices and used simple utility functions. Also options were considered as being independent. At later stages dependencies between trips and choices were taken into account such as with the tour-concept [28].

More recently, refinements to discrete choice theory were being introduced with respect to among others types of preference functions (compositional, decompositional, multiplicative, etc) and relationships between alternatives [29].

A recent development too is the recognition of the importance of individual constraints with respect to travel choices: earlier insights about mode captivity, mostly dealing with car availability are being enlarged by a more general treatment of constrained choices with respect to various modes (application of Broegaert/situational analysis in Delft [25]).

Especially discrete choice theory played an important role in formulating transportation policies. The insights derived about elasticities and cross-elasticities of travel demand on the basis of discrete choice models were used in evaluating infrastructural and pricing measures of the government.

Apart from micro-economic based approaches, also theories from the fields of psychology and sociology have been adopted. Especially modal choice has been studied using among other things Fishbein's attitude theory which takes normative beliefs into account (see e.g. [26]).
Using equilibrium theory the effects of limited capacities upon demand was studied. Contributions to this theory (especially solution algorithms) were developed in the course of studies into the future development of the national high-level road network (see e.g. [22]).

Significant attention received the development and use of space-time activity scheduling theories. A first step in this development was the hypothesis of a constant travel budget for personal travel needs. This hypothesis received widespread attention in behavioural research and was adopted in explaining travel phenomena (see e.g. [6]).

The activity approach stresses that travel patterns are dependent on activity patterns and vice versa, and that travel behaviour should be studied as a derivative of activity choices. Activity choices are the result of a complex process of interaction between household members having their own needs, desires, and constraints.

Most of the studies deal with the effects of changing conditions (e.g. in household composition, employment characteristics, public transport services, shopping hours) upon the scheduling of activities and consequently on the travel behaviour (see e.g. [5,7]). A dominant role in the analyses plays the existence of all kinds of constraints that limit the possibilities of adapting behaviour.

With respect to dynamics, theories hypothesizing maximum preservation of traditional behavioural patterns (e.g. Festinger's cognitive dissonance theory) are favoured.

6.2 Location and mobility

Based on the success of discrete choice models in travel behaviour research, also in residential location choice the micro-economic based discrete choice theory has been adopted to study preferences for location characteristics and to learn about trade-offs made by households (see e.g. [21,23]).

This approach has been widened to the joint choice of housing and working location in order to formulate models explaining migration and commuting behaviour (see e.g. [20]).

More recently, the locational behaviour of firms and offices has been investigated within this theoretical framework.

At a more aggregate level, theories are developed dealing with the development process of urbanised regions. Locational choices of actors are modelled using micro-economic, discrete-choice theory whereas the development of the system is considered being constrained by equilibration processes of supply and demand on the housing and transportation markets. The theory tries to explain development sequences such as urbanization, desurbanization, reurbanization, etc. [27].
Analytical tools

7.1 Transport Demand

Most of the new analytical tools have been developed and used in the course of modelling individual choice behaviour. Predominant here are the mathematical approaches and statistical estimation techniques. The utility (preference) functions mostly are estimated on the basis of the logit specification of the choice models using cross-sectional revealed preference data. More recently, also probit-type models come into play. Also the type of data used in estimation was widened. Many applications of stated preference data and related estimation techniques (conjoint measurement) have been used to derive behavioural parameters (see e.g. [26,35]). In some cases model estimation was done using longitudinal data stemming from before-and-after studies or from panel surveys.

Application of these techniques was not at all restricted to modal choice but covered also route choice, destination choice, train type choice, parking choice, etc.

A second class of approaches may be labelled as micro-simulation techniques. Two types of simulation approaches can be distinguished. The quantitative approaches are used to estimate probabilistic choice models having a complex structure. Examples are known for parking choice behaviour and route choice. For even more complex situations, such as with activity schedules, qualitative simulation has been used. With these simulations the probable responses in activity and travel choices to hypothetical changes in background conditions are assessed for individuals and households. An important outcome of such simulations is the degree of freedom-of-choice and the types and severity of constraints that limit individuals to change their behaviour. With such simulations a good insight can be gained into the way how individuals and households respond to intended policy measures so that their efficacy and potential negative or even counterproductive effects can be assessed. Applications are known, among others, of the HATS- and CARLA-techniques to study the behavioural response pattern to an improvement in rural public transport services (see e.g. [5,36]) and of the situational approach to study the constraints structure in mode choice (see e.g. [25]).

An often used technique is doing real-life 'experiments' and analysing changes in behaviour using before-and-after studies. Such experiments have been carried out among others with respect to the opening of new railway lines, new major road facilities (bridges and tunnels), new public transport fares, new types of road network designs in urban areas. In most cases mode choice was the most important dependent variable.

Most of the older research was based on cross-sectional data. This means, behavioural insights were derived from the comparison of different persons under different conditions. In order to circumvent a number of drawbacks of this approach a systematic col-
lection of longitudinal travel data for a panel of households has been started by the government a number of years ago. These longitudinal panel data are used to analyse changes in behaviour, especially mode choice, in response to changes in various background conditions such as fares, fuel prices, household changes, etc. Turn-over tables are one of the techniques to determine individual response effects from this type of data (see e.g. [24]).

Many new tools have been developed in the course of the establishment of aggregate travel demand forecasting model systems. A typical example is the class of constrained optimization techniques for origin-destination flows that can make use of various types of travel information (see e.g. [37]).

7.2 Transport Supply

The feasibility and efficacy of policy instruments mostly has been studied using paper-and-pencil methods. In some cases however, also real-life experimentation has been applied. The effects of the network lay-out and street design in urban areas upon travel choices has been studied for example by implementing a large number of different designs in a systematic way and comparing the travel patterns of the users. Also new forms of public transport (so-called para-transit) have been studied using experimental approaches.
References

[1] Schrijnen, P.M.
Autobezit en autogebruik (Car ownership and car use)
Amsterdam, University of Amsterdam, Jan 1986 (in Dutch)

Auto en overheid (The car and the government)

New developments in modelling travel demand and urban systems:
Some results of Dutch research.
Westmead (UK), Saxon House, 1979

Transportation and mobility in an era of transition.
Amsterdam, North Holland Publ., 1985

Time in travel.
Groningen, University (Ph.D. dissertation), 1987

The law of constant travel time and trip rates.

[7] Hoorn, A.I.J.M. van der
Development of an activity model using a one-week activity diary.
In: Carpenter, S.M. & P.M. Jones (eds). Recent advances in travel
demand analysis. Gower, 1983, pp. 335-349

Changing patterns of urban travel.
Paris, ECMT, 1985

[9] Borchert, J.G. et al. (eds.)
Urban systems in transition.
Netherlands Geographical Studies Vol. 16
Amsterdam/Utrecht, KNAG/GIRU, 1986

Transportation and stagnation: challenges for planning and
research. Proc. 10th Intern. Conf. 1983 Zandvoort (Netherlands)
Delft, CVS, 1983, two volumes

Income decline and travel behaviour: some recent Dutch findings
and research orientations.
In: [4], pp. 37-53

A car availability model: development and application.
In: [3], pp. 75-92

- 24 -
Effects upon modal choice of a parking restraint measure.

[14] Enden, A. C. J. M. van den & C. W. W. van Lohuizen
Access, egress and modal choice.
In: [10], Vol.2, pp.85-103

Mode choice and mode captivity in interlocal commuting: two Dutch studies on modal split in congested transportation corridors.

[16] Meer, G. M. van der & I. J. Boeckhout
Telematica, verkeer en vervoer en overheidsbeleid.
(Telematics: traffic, transport and governmental policy)

[17] Donnea, F. X. de
The determinants of transport mode choice in Dutch cities: some disaggregate stochastic models.
Rotterdam, University Press, 1971

[18] Hoorn, A. I. J. M. van der & J. Vogelaar
SIGMO: disaggregate models for the Amsterdam conurbation.

[19] Ashley, D. J. et al
The long distance travel model for the Netherlands.
In: F. le Clercq (ed). Colloquium Vervoersplanologisch Speurwerk 1985
Delft, CVS, 1985, pp.397-413

[20] Evers, G. H. M. & A. van der Veen
A simultaneous non-linear model for labor migration and commuting.

[21] Rima, A. & L. van Wissen
A dynamic model of household relocation: a case study for the Amsterdam region.
Amsterdam, Free University Press (Ph.D.diss.), 1987

[22] Steenbrink, P. A.
Optimization of transport networks.
London, Wiley, 1974

[23] Lierop, W. van
Spatial interaction analysis and residential choice analysis.
Amsterdam, Free University (Ph.D.diss.), 1985

A dynamic analysis of travel demand.
Transportation Research, Vol.20A(1986)No.5, pp.401-414

- 25 -
Evaluatie Fietsroutenetwerk Delft: marges voor het fietsgebruik.
Den Haag, Rijkswaterstaat, Dienst Verkeerskunde, 1986 (in Dutch)

The use of attitude models and stated preference models in
practical transport analysis.
In: Behavioral Research for Transport Policy.

[27] Berg, L. van den & L. H. Klaassen
Economic cycles, spatial cycles and transportation structures
in urban areas.
In: [4], pp. 259-273

[28] Antonisse, R. W., Daly, A. & H. Gunn
The primary destination tour approach for modelling trip chains.
In: PTRC (ed), Transportation Planning Methods, Proc. PTRC Summer
Annual Meeting, 1986, pp. 165-177

[29] Borgers, A. W. J. & H. J. P. Timmermans
A context-sensitive model for spatial choice behaviour.
approaches in geography and policy analysis.
Croom Helm, 1986

Ruimtelijke verkenningen hoofdinfrastructuur (RUVEIN).
(Studierapport Rijksplanologische Dienst no. 33)
Den Haag, Rijksplanologische Dienst, 1986 (in Dutch)

[31] Langen, M. de & A. C. P. Verster
View on location behaviour, moving behaviour and accessibility.
In: [3], pp. 161-199

[32] Holtgrefe, A. A. I.
Stagnation and public transport in the Netherlands: demand, cost,
supply and planning.
In: [4], pp. 335-351

[33] Ruijgrok, C.
Transport and mobility research in a changing social and
technological context.
In: P. Nijkamp & S. Reichman (eds). Transportation in a changing

[34] Slob, G.
Accessibility as a locational factor for business establishments.
In: [3] pp. 200-221

Stated preference techniques in measuring travel elasticities.
In: [4] pp. 201-210
Simulation studies as a tool for determining public transport services in rural areas

[37] Maarseveen, M. F. M. M. van, et al
Estimating OD-tables using empirical route choice information with application to bicycle traffic
Transportation Research Record, No. 1045, pp. 15-23
Appendix-4: Theme report policy analysis

coordinator: H.J. Noortman
5.0 INTRODUCTION

In this section, dedicated to policy analysis, megatrends, research issues and analytical tools will be discussed that are considered relevant to policy preparation, policy formulation and the evaluation of the impacts of policy implementation.

As the TCM policy has strongly been influenced since the middle of the seventies by three megatrends the research issues here will be related as much as possible to one or more of these three trends.

5.1 MEGATRENDS

During the last decade the TCM policy in the Netherlands has strongly been influenced by some partly interlinked megatrends:

5.1.1 a desire to lower the level of public expenditure
5.1.2 a trend towards less government intervention
5.1.3 an increasing social and economic integration of the various parts of the world

5.1.1 The pressure to reduce public spending can be considered as a strong incentive for reconsidering the many-sided government intervention in the transport and communication sector, which was gradually building-up between the mid-fifties and the mid-seventies.

This reduction of public spending followed a long period of increasing public expenditure, made possible by the gradual rise in GNP and the increasing state-earnings from natural gas sales.
This push from the side of available resources went hand in hand with the pull to create a social welfare-state. Transport was seen as an important instrument variable to achieve a better quality of life. Transport in this connection had to function as a tool to fulfill the objectives of physical and environmental planning.

Increasing car-ownership resulted in a declining share of public transport in the total mobility. Given the high level of public transport services maintained, the amounts of money needed to finance the deficits showed an exponential development. At the same time other areas of government responsibilities claimed fast increasing amounts of public resources.

The economic recessions in the seventies all of a sudden made it clear that public expenditures should be reconsidered. Not only the exponential development in government spending had to be halted, but a downward trend had to be started. Under these circumstances a reconsideration of the effectiveness of public expenditure in the transport sector was unavoidable.

5.1.2 As mentioned before, the need to bring down the level of public spending was an incentive to analyse the effectiveness of that spending, given the objectives of government’s involvement.

- In the transport sector the effectiveness of the public transport policy asked for special attention. An analysis of the results achieved with 14 years of high subsidies brought into the open that the increase in mobility during that period was fully due to extra car trips. The public transport policy objectives, formulated in the "Structuurschema Verkeer en Vervoer" were different for the large urban areas and for the rest of the country. In the large urban areas the modal choice had to be influenced in favour of public transport, the bicycle and walking. For the rest of the country public transport had to
provide services complementary to the private modes of transport. One may conclude that the transport policy objectives outside the large urban areas had been achieved - in these areas a fair quality of public transport services was maintained. However, for the large urban areas the policy was less successful. Although the total patronage of public transport could be stabilised, this share had strongly declined instead of increased.

However, the reconsideration of government's involvement was not wholly induced by the need to bring down public expenditure.

The overall effectiveness of the trend-setting government policy was criticised more and more, given the disappointing results:

- Land-use patterns adapted themselves fully to the possibilities opened by the private car and did not follow the objectives of the environmental planners.

- Government's steering power in freight transport failed under conditions of declining economic activities. The regulations developed in the fifties appeared to have been ineffective and hampered the necessary flexibility of the transport industry under changing economic circumstances. The tour-de rôle system in domestic inland navigation had not been an adequate instrument to strengthen the position of the smaller shipowners and had slowed down the adoption of the fleet to changing needs. The licensing system for freight transport by road has failed as an instrument to bring demand and supply in equilibrium under circumstances of economic recession. The continuation of a capacity stop for more than 10 years was not only ineffective as a tool to achieve a better balance between supply and demand in the road transport sector, but also obstructed investment needs of the companies that provided their services to those sectors of the economy which were expanding.
The overattention that was given during a long period of time to the mobility needs of the private households had as consequence that the need for adequate facilities on behalf of the production households was neglected.

These production households have three types of accessibility needs: for their employees, for their clients and for freight. As a policy the private car was approached as consumer goods. Its negative external effects led to a strategy which should slowdown its use, especially in urban areas. This policy did not only result in the earlier mentioned stimulation of public transport patronage, but also in infrastructure provisions which lagged far behind the demand for capacity. As a consequence, however, not only the passenger cars were confronted with increasing congestions, but also freight transport was seriously harmed. This, due to the fact that freight transport has to share the same infrastructure facilities with passenger cars. Decreasing accessibility of the traditional economic centres made them lose their attractiveness as a location. A decline in employment in those areas was setting in.

The disappointing results of the various forms of government intervention in the transport sector asked for a reorientation. In 1982 the Netherlands' government actually started a deregulation policy, extra pressed by the negative side effects of the many regulations, becoming evident since the recession of the late seventies. The trend towards deregulation got an extra stimulus when it became more and more apparent that this recession was not a temporary decline in business activities, but resulted from structural changes in the economy on a global scale. Changes which made a fundamental reorientation of the economic and transport policy necessary.
5.1.3 With this we reach the third mentioned megatrend: the increasing social and economic integration of the various parts of the world. Since the last two decades some fundamental changes in the social and economic patterns took place and did so with an increasing intensity and speed.

Stimulated by technological developments the spatial distribution of economic activities changes. The USA and Western Europe had to abandon an important part of their historic economic activities. These two old industrial centres had to give up a large part of their mining sector and of their heavy industry in favour of the newly industrialized countries. These countries as well as some developing countries have also penetrated the light industry and the labour-intensive sectors of the economy. The economies of the various parts of the world became strongly interdependent. Large parts of the production fall under the organisational control of transnational companies with plants distributed all over the world. The high costs of research and technological development make it necessary to distribute a new product immediately over all available markets. The traditional markets have become too small for the production volumes which are needed to cover the costs of R and D. This "globalisation" of the economic activities was made possible by the introduction of new concepts in the enabling technologies of which transport and communication form the hard core.

In order to stop the decline in employment in Western Europe and to create new employment, the West-European industry has to widen its traditional market to the other parts of the world. This asks not in the last place for a fundamental shift in the European transport policy towards deregulation, to make the application of the necessary logistic concepts possible. The large-scale production of consumer goods, with a worldwide distribution, brings the tasks and preferences of increasing numbers of people closer together. The improved technology of communication and transportation stimulates the homogeneity in lifestyle.

14-10-1987/hno4/g5
As the economy of the Netherlands is strongly dependent on its international distribution function, the developments mentioned requires special attention. The traditional distribution channels and systems are no longer optimal. The relative position of the Port of Rotterdam within these global distribution systems becomes less secure. New facilities are needed, adapted to the changed conditions and needs.

These changes in the social and economic patterns have also resulted in a re-orientation on the objectives for environmental planning.\textsuperscript{')}

A basic question to be answered in the preparation of a new policy for environmental planning is for instance: how can environmental planning create favourable conditions for the stimulation of international economic development, parallel to its care for a good quality of living conditions in the regions with economic growth. In this re-orientation of the environmental planning policy, the role of the government as trendsetter is considered less important compared with its task of middleman and advisor. However, trendsetting cannot be missed, where vital living conditions are threatened.

The fundamental desire of the human being to enlarge its activity space up to the limits set by the available time and money budgets explains the fast increase in mobility over large distances, made possible by "new" forms of transport by car and airplane, available against relatively low prices.

A transport policy that tries to prevent a further increase of mobility can be given little hope of being successful.

\textsuperscript{')} See RPD: Ruimtelijke perspectieven. Op weg naar de 4e nota over de ruimtelijke ordening, 1986.
5.2 RESEARCH ISSUES

5.2.1 The need for government intervention.

The transport policy in Western Europe is strongly influenced by reasons of government intervention that lay outside the functioning of the transport sector. Nevertheless there exists a long tradition to conceal the real reasons for government interventions under the pretext that only economic arguments are relevant. Economic arguments with as nucleus the "theory of the inherent instability of the road transport market".

Based on this theory a far-reaching government intervention in the road transport sector was justified formally to prevent cutthroat competition within the road transport sector, actually to defend the interests of the railways, that formed an important instrument for the governments in implementing their economic and social policy. Furthermore one should keep in mind that the railways were the main inland carrier of the armed forces.

Since the importance of the railways as instrument variable is declining in many areas of economic and social activities and road transport has to provide an increasing part of the transport services, the needs for regulation ask for a reconsideration. As was mentioned before, a general trend towards deregulation in the Netherlands was set in during the beginning of the eighties. It seems doubtful that just by deregulation, an optimal transport policy can be developed. There are many signs that some form of re-regulation is a more adequate policy-line. A re-regulation not only to cope in a proper way with the negative externalities of the transport sector but as well to create the best institutional conditions for the economic functioning of the sector. A detailed analysis of that functioning under a more liberal policy is needed to find a reliable basis for re-regulations. The experiences with the functioning of the transport sector under various forms and degrees of government intervention should therefore be studied in detail.
5.2.2 The effectiveness of the transport sector as an instrument variable.
As mentioned before, the greater part of government intervention in the transport sector results from the desire to use this sector as an instrument variable to achieve results in other areas of government responsibility.

Given the disappointing results in this connection of the achievement of the objective for environmental planning and regional development, a detailed analysis is needed of the conditions under which the use of transport facilities as an instrument variable can be successful.

5.2.3 In spite of the large amounts of public funds used for subsidising public transport over a long period of time, this form of passenger transport has lost ground. A reconsideration of the public transport policy is therefore necessary.
Low prices have shown not to be effective to attract car drivers. Neither did a lowering of the quality of the infrastructure facilities for the cars result in an important shift towards public transport.') The last mentioned policy only lowered the overall quality of life and frustrated the proper functioning of the economy.

The public funds, allocated to the stimulation of public transport patronage should be used to handle other instruments than low fares. To attract car drivers, the improvement of quality of service elements by public transport will probably be much more effective. Under improved quality of service conditions a price increase is justifiable.
An analysis of the sensitivity of the modal choice for quality improvement should be given a high priority.

More or less implicitly the rather emotional point will have to be answered, whether a more market oriented public transport policy can be successful if with one and the same system the following three categories of passengers have to be served:

- the car owners asking for a high quality of service
- the elderly and the handicapped, needing adapted facilities and
- the poor, demanding cheap public transport services.

5.3 GAPS IN KNOWLEDGE

From the research issues discussed in paragraph 2 follows that with each of these issues at least one gap in knowledge is related:

5.3.1 The degree of regulation, needed for a proper economic functioning of the various modes of transport and the most desirable forms of regulation, per mode.

5.3.2 The relevance and relative weight of transport facilities for environmental planning and regional development, under various local conditions.

5.3.3 The sensitivity of the modal choice of car owners for various quality of service elements in public transport.
5.4 EMERGING RESEARCH DIRECTIONS

5.4.1 The necessity to reduce the volume of public spending gave a strong incentive to look for new approaches in governmental management.

Questions like:

- What transport-related services have to be provided by the government because of the need to exercise typical public authority.
- What degree of centralisation or decentralisation is needed to implement government's intervention.
- How to improve the consistency in intervention both along horizontal and vertical lines within the total government system,

requires a reconsideration of structures that have proved to be very resistant to change-initiatives. Important work in this field of management science has already been done by Prof. Dr. L.A. Geelhoed of the Erasmus Universiteit and Mr. J. de Ru of the Free University.

5.4.2 In the transport policy approach at Common Market level progress was up till now almost blocked by the fundamental difference of opinion between continent countries like Germany and France opposite the more global oriented countries like the UK and the Netherlands. A deal to reach a next step in liberalisation is always conditioned with a demand for harmonisation of the competitive terms. The impact of such a harmonisation on the cost level, the flexibility and the degree of efficiency of the transport industry was not given much attention. However, since the globalisation of the economic activities has as consequence that the West-European industry has to widen its markets outside Western Europe, the cost level of the freight transport services together with their sophisticatedness have become of strategic relevance for the future of Western Europe.
Research into this relevance and into the possibility to strengthen the competitive position by the development of adequate logistic systems has started. In this connection can be mentioned the joint research effort of the University of Amsterdam, the Netherlands Economic Institute and the Economic Bureau for Road and Water Transport.

5.4.3 The need to bring down public spending did not only result in a critical analysis of tasks that have to be fulfilled by the government and those that could be considered for privatization. Beside this very important analysis, research work has started to improve the professionalism of management in government-owned companies. This asks for more than a straight forward application of standard principles of business administration. The balanced distribution of responsibilities and competences between the political level and the management of the transport company is one of the major areas of new approaches. Steps in that direction are made by specialists in transport management and operation as well as by some representatives of the management science.

5.4.4 The desire to cope with the negative external effects of (auto) mobility resulted in many experiments at national level as well as at municipal level. To check whether these various experiments brought the desired results, evaluation studies were introduced. As examples can be mentioned:

- the evaluation of the effect of the "Van der Doef" ticket on public transport patronage.\(^1\)
- the evaluation of the repercussions of the traffic circulation plan of Groningen by J. Buit and J. Walen
- the evaluation of the impact of infrastructure facilities for bicycles in The Hague, Tilburg\(^2\)
- the evaluation of the introduction of 'woonerfs'\(^3\)

---

5.5 THEORETICAL DEVELOPMENTS

5.5.1 The mobility and location patterns that developed during the last decades were not only in conflict with the policy objectives, but asked at the same time for a reconsideration of the basic assumptions used in the policy preparation. An important example in this connection are the theories assuming that trip behaviour is directed by the desire to minimize the generalized travelling costs. For trips that can be realised within the limits set by the individual time and money budgets allocated for travelling, these theories have to be abandoned.

Time-space modelling requires the explicit introduction of locational preferences as far as the subjective evaluation of the consumption of goods and services is concerned. The objectives of environmental planning have to be adapted to these locational preferences.

5.5.2 Many theoretical constructions used as a justification for an intensive government intervention, especially in the area of freight transport, define the total demand for freight transport services as inelastic. The reasoning is that the demand for transport is a derived demand, fully depending on the demand for goods. The incorrectness of this assumption is evident. The saying "trade follows the flag" has proved to be highly topical. To be sure, the increasing economic integration on a global scale was just made possible by the modern transport and logistical concepts. The interdependence between demand for and supply of transport facilities has therefore to be elaborated and the impact of this interdependence integrated in the freight transport policy.
5.6 ANALYTICAL TOOLS

5.6.1 As mentioned before, many experiments have been done to test the effectiveness of policy tools. Before and after studies were the most frequently used analytical tool. Examples of application were given in par.5.4.4.

5.6.2 Analyses on a broader scale focused on the evaluation of the results of a specific policy line. As examples can be mentioned:
- the analysis made by the "Algemene Rekenkamer" of the results achieved after fourteen years of subsidies in the public transport sector
- the analysis of the impact of the tour-de-rôle system on the structure and functioning of inland navigation, by the "Commissie Geelhoed".

5.6.3 To test the effectiveness of policy alternatives in the stage of policy preparation, simulation techniques were developed and applied to estimate the impacts of the alternatives. For freight transport experiments are made to expand these models with other components of logistic services.
Appendix-5: List of respondents
APPENDIX-5: List of Participants

Baanders, A.
Ministerie van Verkeer en Waterstaat
Directoraat Generaal voor het Vervoer,
Postbus 20901,
2500 EX DEN HAAG.

Blauwens, A.J.
Erasmus Universiteit,
Burgemeester Oudlaan 50,
3062 PA ROTTERDAM.

Blok, P.M.
Nederlands Economisch Instituut,
Burgemeester Oudlaan 50,
3062 PA ROTTERDAM.

Boeckhout, J.
Nederlands Economisch Instituut,
Burgemeester Oudlaan 50,
3062 PA ROTTERDAM.

Bovy, P.H.L.
Research Institute of Urban Planning and Architecture,
Delft University of Technology,
Berlageweg 1,
2628 CR DELFT.

Clercq, F. Le
Dienst Ruimtelijke Ordening
Gemeente Amsterdam
Wibautstraat 3,
1091 GH AMSTERDAM.

Drewe, P.
Vakgroep VROM, Faculty of Architecture
Delft University of Technology
Berlageweg 1
2628 CR DELFT.

Hamerslag, R.
Department of Civil Engineering,
Delft University of Technology,
Stevinweg 1,
DELFT.

Hoorn, A.I.J.M. van der
Rijkswaterstaat Dienst Verkeerskunde,
Koningskade 4,
2596 AA DEN HAAG.

Jansen, G.R.M.
Research Institute of Urban Planning and Architecture,
Delft University of Technology
Berlageweg 1,
2628 CR DELFT
Appendix-6: Some publications on Dutch TCM-research
Representative internationally accessible publications can be found:

- in the lists of references at the end of individual theme reports, where if available publications in English were listed.
- the multi-volume proceedings of the annual meetings of the Colloquium Vervoersplanologisch Speurwerk. Every paper has an English summary.
- by scanning the database of the International Road Research Documentation.
Het OSPA, Onderzoeksinstituut voor Stedebouw, Planologie en Architectuur, is voortgekomen uit een fusie van het voormalige Instituut voor Stedebouwkundig Onderzoek (ISO) en het Centrum voor Architectuuronderzoek. Door deze werkverbanden zijn onder meer de volgende publicaties uitgebracht.

RAPPORTEN EN WERKSTUKKEN VAN HET INSTITUUT VOOR STEDEBOUWKUNDIG ONDERZOEK

Rapporten:

47. JANSSEN, G.R.M. & VUREN, T. VAN "De externe vervoersrelaties van de vier grote steden in Nederland: een empirische studie". 1985

48. BOVY, P.H.L. "Evaluatie fietsroutenetwerk Delft voorstudie: routekeuze en netwerkgebruik". 1985

49. VUREN, T. VAN "Schattingsmethoden voor een herkomst-bestemmings-tabel". 1985

50. VEEKE, P. "De volgobservatiemethode in het verkeersonderzoek: een methodische studie naar toepassing bij fietsverkeer". 1985

51. KITAMURA, R. & BOVY, P.H.L. "Trip reporting and attrition analysis of the Dutch mobility panel (first two waves)". ('Rapportagefouten en uitvalgedrag bij het nationale mobiliteitspanel'). 1985

52. BOVY, P.H.L. & ADEL, D.N. DEN "Routekeuze van fietsers: een analyse met de functionele meetmethode". 1986

53. SCHOW, R.J. & DRAAK, J.DEN "Bevolking en voorzieningen in beweging". 1986

54. HEUVEL, M. VAN DEN & TACKEN, M. "Verplaatsingsgedrag van werkende vrouwen. Een analyse van kenmerken van verplaatsingen". 1986


57. HELSLOOT, L. "Windkrachtcentrale in het landschap". Beleving van visueel-ruimtelijke effecten. 1986


59. JANSEN, G.R.M. & ADEL, D.N. DEN "Routekeuze van automobilisten: een onderzoek naar kwalitatieve keuzefactoren". 1986

Werkstukken:

9. DREWE, P. & HULSBERGEN, E. D. "Segregation in Rotterdam and the aftermath" (Recent developments concerning ethnic groups in the Netherlands).

10. TACKEN, M. "Motieven voor werktijdkeuze, een verkenning" 1986

11. VISSER, J. G. S. N. "Telecommunicatie-infrastructuur en de gevolgen voor de ruimtelijke structuur en verkeer en vervoer". Een verken­nende studie naar de consequenties van nieuwe ontwikkelingen in telecommunicatie-infrastructuur. 1986


RAPPORTEN VAN HET CENTRUM VOOR ARCHITECTUUR ONDERZOEK:


- VOORDT, D. J. M. VAN DER "Dagverblijven en gezinsvervangende tehui­zen voor geestelijk gehandicapten". Achtergronden, documentatie en analyse. 1986

- STEFFEN, C. "De invloed van stedelijke verdichting op de behoeften- satisfactie". 1986

- STEFFEN, C. & VRIELINK, D. "Veranderbare HAT-woningen". Gebruiks­evaluatie verplaatsbare kastenwanden en randbalken in de kapruimte. 1986


- VOORDT, D. J. M. VAN DER & WEGEN, H. B. R. VAN "Ruimtelijke structuur en kleine criminaliteit". Interim-checklist voor aandachtspunten bij de beoordeling van (stede) bouwkundige plannen. 1986

- VOORDT, D. J. M. VAN DER, "Slachtofferschap en wonenmilieu". Secundaire analyse van een CBS-databestand. 1986
RAPPORTEN EN WERKSTUKKEN VAN HET ONDERZOEKINSTITUUT VOOR STEDEBOUW, PLANOLOGIE EN ARCHITECTUUR

Rapporten:


2. TACKEN, M.H.H.K. "Het windklimaat voor verblijf in stedelijk gebied; een aanzet tot normering". 1987


Werkstukken:

1. JANSEN, H.F.M. "Verkenning van de beheers- en onderhoudsaspekten van geluidwerende voorzieningen langs wegen". 1987

2. DREWE, P. "The coming economic cycle and the built environment. Conjectures without refutation". 1987


I.S.O.-, C.A.- en O.S.P.A.-rapporten c.q. -werkstukken kunnen worden besteld bij het Onderzoeksinstituut voor Stedebouw, Planologie en Architectuur, Berlageweg 1, 2628 CR DELFT, Tel. 015-781088, 781308 of 783928