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RIJKSINSTITUUT VOOR VOLKSGEZONDHEID EN MILIEU
NATIONAL INSTITUTE OF PUBLIC HEALTH AND THE ENVIRONMENT

RIVM report 773002 014

Ecological, Social and Economic Evaluation of Transport Scenarios: An Integral Approach

PhD Research Programme

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Preface

This report describes a PhD research programme aimed at the development and application of a methodology for the integral assessment of ecological, economic and social impacts of Dutch national transport scenarios. I could not have written this programme without the guidance and useful comments of Professor Bert van Wee. Furthermore, I would like to extend a word of thanks to a large number of colleagues from RIVM, and other organisations both inside and outside the Netherlands, who have taken the time to read and discuss the draft version of this research programme. Specifically, I would like to name (in alphabetical order): Professor John Adams, Professor David Banister, Leon Crommentuijn, Martin Dijst, Eric Drissen, Jan Ritsema van Eck, Professor Toon van der Hoorn, Nelly Kalfs, Marianne Kuijpers-Linde, Professor Peter Nijkamp, Professor Piet Rietveld, Rob van de Velde, Nol Verster and Jan van der Waard for their useful comments.

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Samenvatting

In Nederland en het buitenland zijn onderzoeks- en beleidsvragen steeds vaker gericht op een integrale beoordeling van scenario's of beleidsmaatregelen op milieu-, economische- en sociale consequenties. Het RIVM, dat in samenwerking met andere instituten en organisaties onder meer de verkeers- en milieugevolgen van alternatieve verkeerssystemen of verkeersscenario's onderzoekt, is ook op zoek naar een meer integrale beoordeling van verkeersscenario's. Bij recente beoordelingen van verkeers- en vervoerscenario's is met name gekeken naar traditionele verkeers- en milieu-indicatoren, zoals voertuigkilometers, energiegebruik en emissies. Bij een meer integrale benadering moeten echter naast de verkeers- en milieugevolgen eveneens de economische en sociale consequenties worden onderzocht. Bestaande methodieken voor de beoordeling van verkeersscenario's zijn echter niet in staat een dergelijke integrale beoordeling uit te voeren.

Dit rapport beschrijft een onderzoeksprogramma voor de ontwikkeling van een methodiek voor de integrale beoordeling van milieu-, economische en sociale consequenties van verkeers- en vervoerscenario's. De geplande onderzoeksactiviteiten omvatten onder meer:
1. een literatuurstudie naar conceptuele modellen voor de verklaring van de samenhangen tussen het verkeerssysteem en het ecologische, economische, ruimtelijke en sociale systeem.
2. een literatuurstudie naar methodologieën voor de beoordeling van verkeers- en vervoerscenario's;
3. een review van de methodologieën die gebruikt zijn bij de ontwikkeling en evaluatie van verkeers- en vervoerscenario's in binnen- en buitenland;
4. de ontwikkeling van een beoordelingsmethodiek voor een integrale beoordeling van milieu-, economische en sociale consequenties van verkeers- en vervoerscenario's;
5. de toepassing van de beoordelingsmethodiek in enkele case studies.

Het RIVM is voornemens het onderzoeksprogramma uit te voeren in samenwerking met andere relevante instituten en organisaties in het binnen- en buitenland.

Summary

Research and policy issues both inside and outside the Netherlands are increasingly related to a "broad" evaluation of ecological, economic and social impacts of projects, plans and policies. The research and policy issues addressed by the Dutch National Institute of Public Health and the Environment (RIVM) – in co-operation with other research institutes and organisations – are often related to "broad" evaluations of the impacts of transport policies, plans or projects. In other words, not only are "traditional" transport and environmental/ecological impacts to be assessed but also economic and social impacts.

This report describes a research programme for the development of a methodology for the integral assessment of ecological, economic and social impacts of transport scenarios. The following research activities are planned:

(1) a literature study on theories and conceptual models, explaining how the landuse transport system functions;
(2) a literature study on methodologies for the evaluation of transport scenarios;
(3) a review of evaluation methodologies used in recent transport scenarios;
(4) the development of a methodology for the ecological, economic and social assessment of transport scenarios;
(5) the application of the methodology in case studies.

RIVM intends to conduct the research programme in co-operation with other relevant institutes inside and outside the Netherlands.

1 Introduction

1.1 The research context

In general, research and policy issues are increasingly being addressed through an integral approach to ecological/environmental, economic and social evaluation of policy plans, programmes or projects. For example, the World Bank has developed an approach to operationalise the concept of environmentally sustainable development (ESD) by a triangular framework - referred to as the ESD triangle – to assess the economic, ecological and social sustainability of specific proposals for funding (see Figure 1.1). A World Bank proposal has to be economically and financially sustainable in terms of growth, capital maintenance and efficient use of resources; ecologically sustainable in terms of ecosystem integrity, carrying capacity and conservation of natural resources; socially sustainable in terms of equity, social mobility, social cohesion, participation, empower-ment, cultural identity and institutional development (Serageldin & Steer, 1994). The Dutch National Institute of Public Health and the Environment (RIVM) has recently published the *Physical Environmental Balance* (RIVM, 1998a) in which the state of the physical environment is analysed from three perspectives: economic, environmental and socio-psychological. This research programme focuses on the integral evaluation of transport scenarios.

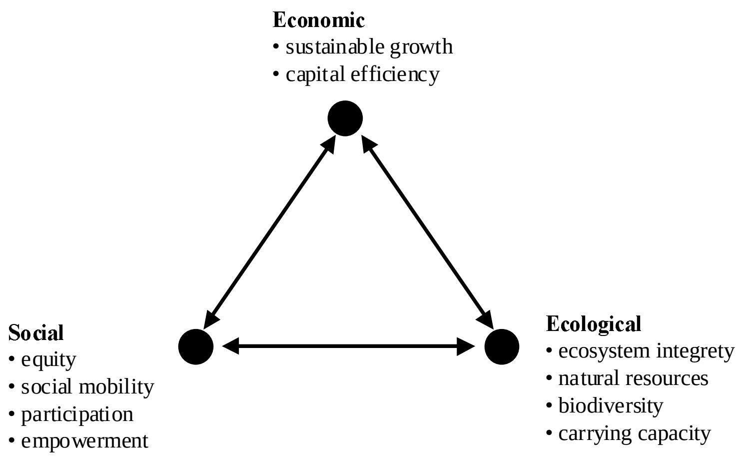

Figure 1.1: The World Bank's ESD triangle.
Source: Serageldin & Steer (1994)

In co-operation with other research institutes and organisations, the RIVM addresses research and policy issues related to future alternative transport systems or – seen in a broader context – the future land-use transport system or transport scenario (see Section 2.2 for a definition) [1]. The research and policy issues in the recent past have usually been related to an evaluation of:

(a) the functioning of the current or future infrastructural network (e.g. vehicle kilometres driven, level of congestion);
(b) the environmental impacts of current or future alternative transport systems and
(c) the environmental impacts of strategic actions (policies, plans and programmes) on a national scale.

[1] In this report, the term "transport scenario" refers to a description of a future (alternative) landuse transport system.

These issues have been addressed by estimating "traditional" indicators, e.g. the number of car vehicle kilometres and public transport passenger kilometres, the level of service of new infrastructure, energy use, emissions and noise. These indicators are derived, assuming a certain socio-economic context, from the construction of transport scenarios using national transport models (see for example RIVM, 1997).

Recent research and policy issues addressed by the RIVM are increasingly related to a "broader" evaluation of transport scenarios, i.e. where ecological (e.g. landscape, nature), economic (e.g. employment, costs) and social impacts (e.g. quality of life, equity aspects) are to be evaluated. However, current evaluation methodologies at the RIVM are not able to fully incorporate these issues. Thus, the evaluation of transport scenarios could be much improved by using a more integral methodology for determining the ecological, economic and social consequences. The outcome of such a broad evaluation of, for example, public investment plans for infrastructure (e.g. high-speed rail) or alternative transport systems (e.g. public transport, light rail) could turn out to be much different than traditional evaluations.

1.2 Research objective and issues

This research programme is set up to:
develop, apply and evaluate a methodology for the integral assessment of the expected ecological, economic and social consequences of transport scenarios.

The research issues addressed are:

1 Which ecological, economic and social indicators are relevant for describing the impacts of transport scenarios from a theoretical/conceptual point of view;

2 Which ecological, economic and social indicators have already been sufficiently dealt with in the current state-of-the-art transport scenario evaluations from a theoretical and methodological point of view, and which ones have not been sufficiently dealt with?

3 Which are the most important ecological, economic and social indicators not yet sufficiently dealt with in current state-of-the-art transport scenario evaluations and how can these be assessed and applied to the evaluation of Dutch national transport scenarios?

1.3 Structure of the report

The report is organised in sections as follows. After the introduction comprising this section (1), section 2 will addresses the main research issues and (a) describe a conceptual model for the functioning of the landuse transport system, (b) describe the indicators used in recent Dutch transport scenario evaluations and (c) discusses the most important "gaps in knowledge". Section 3 overviews the research programme, including a literature review of (1) theories and conceptual models on the functioning and impacts of the landuse-transport system, (2) methodologies for evaluating transport scenarios and (3) existing transport scenario studies, (4) the development of a methodology for evaluating future alternative transport scenarios and (5) an application of the case study methodology. Sections 4 discusses the methodology development in more detail and section 5 the case studies. Section 6 describes the planning of the research phases in time, followed by section 7, which briefly describes links with current RIVM projects and relevant institutes currently involved in transport scenario evaluations.

2 Elaboration of the research issues

2.1 Introduction

This section will elaborate the three main research issues of the research programme:

1 Which ecological, economic and social indicators are relevant for describing the impacts of transport scenarios from a theoretical/conceptual point of view? Section 2.2 describes a conceptual framework necessary to answer this research issue.

2 Which ecological, economic and social indicators are already sufficiently dealt with in the current state-of-the-art transport scenario evaluations from a theoretical and methodological point of view, and which are not sufficiently dealt with? Section 2.3 describes the indicators used in recent Dutch transport scenario evaluations conducted by the RIVM in co-operation with other institutes and organisations;

3 Which are the most important ecological, economic and social indicators that have not yet been sufficiently dealt with in current state-of-the-art transport scenario evaluations and how can these be evaluated? Section 2.4 discusses the, most relevant research issues (or “gaps in knowledge”) in current transport scenario evaluations at the time of writing this report.

2.2 Selection of ecological, economic and social indicators: a conceptual model

The question which indicators are relevant for describing the ecological, economic and social impacts of transport scenarios refers to the criteria for selecting indicators. There are several selection criteria for indicators. The OECD (OECD, 1999) reviews transport-environment indicators according to three main criteria split into several sub-criteria:

1. Policy relevance and user utility, e.g. a/an (environmental) indicator should:
    - provide a representative picture of environmental conditions, pressures on the environment or society’s responses;
    - be simple, easy to interpret and able to show trends over time;
    - be responsive to changes in the environment and related human activities;
    - have a threshold or reference value against which to compare it.
2. Analytical soundness, i.e. an indicator should:
    - be theoretically well-founded in methodological[2] and scientific terms;
    - be based on international standards and international consensus about its validity;

[2] The OECD (OECD, 1999) uses the term technical.

- lend itself to being linked to economic models, forecasting and information systems.

3. Measurability, taking into account data availability and quality.

These criteria describe the "ideal" indicator, and not all of them will be met in practice. Here, the criteria mean that the indicators for the impact of the landuse transport system should give - a representative, measurable and theoretically founded - picture of the interactions between the landuse transport system and the ecological, economic and social system, and that they should be responsive to changes in the land-use transport system. Therefore, to handle the complex system of relationships within the landuse transport system outside with the economy, society and a conceptual model – to simplify the complexity of the system - is necessary for the selection of indicators.

Figure 2.1 presents a conceptual model to explain the functioning of the landuse transport system and its relationships with the socio-cultural and economic systems. The conceptual model is based on a "quick scan" literature study; the research programme comprises a more elaborate literature study, in which the conceptual model will be finalised. The preliminary model is described briefly below.

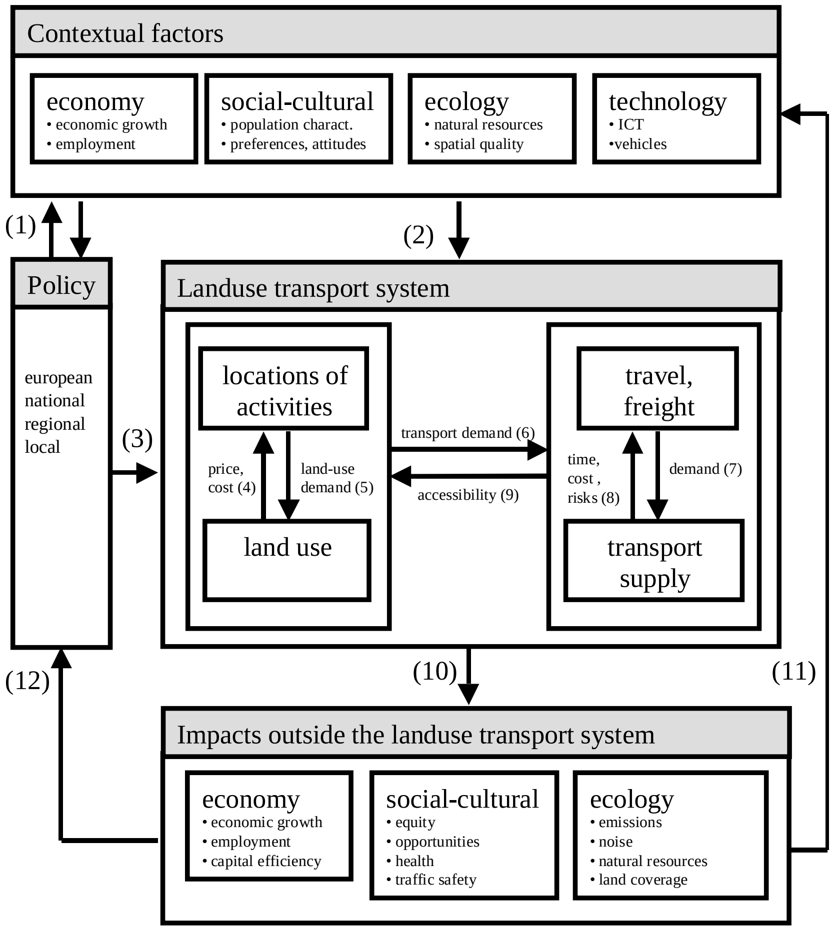

Figure 2.1: Conceptual model for the functioning of the landuse transport system

Contextual factors and governmental policy

Contextual factors interact in a two-way path with governmental policies (i.e. transport, land use, environmental and other policies on the European, national, regional and local levels) (1). For example, attitudes and preferences of the population determine governmental policies (e.g. via elections), and governmental policies influence people's attitudes and preferences (e.g. via information). Furthermore, contextual factors co-determine the functioning and impacts of the landuse transport system (2). Contextual factors can be described by:

- the characteristics of the *economy*, e.g. the level of economic growth, employment, and sectoral and regional structure of the economy;
- the socio-demographic and *socio-cultural* characteristics of the population, e.g. the age and income distribution of the population, including (travel) needs, preferences and attitudes of the population;
- characteristics of the *ecology/environment*, e.g. the quantity of natural resources such as fossil fuels, the ecological/environmental quality of an area.
- the level of *technology* development, e.g. information and communication technology (ICT), vehicle technology.

Governmental policies (e.g. investments in transport infrastructure, fuel taxes, location policies) influence the landuse transport system directly (3) and indirectly (via the contextual factors).

The landuse transport system

The central part of the conceptual model is formed by the landuse transport system, i.e. the interdependent system of land use and transport. The landuse system and transport interact in a two-way path: i.e. the spatial distribution of land use (e.g. locations of houses, enterprises, schools, shops and the characteristics of the land use, such as density, diversity and design) determines (4) the locations of human activities (e.g. living, working, shopping, education or leisure). The spatial distribution of activities co-determines the need for land use (5) and creates the need for travel and movement of goods in the transport system to overcome the distance between the locations of activities (6).

People's needs for travel and movement of goods creates the need for transport supply, i.e. supply of infrastructure, vehicles and fuel (7). Here, transport supply is described as

(a) the physical characteristics of infrastructure (e.g. road length, location, road capacity, speed limits), and
(b) the characteristics of infrastructure use (e.g. distribution of traffic levels over time, the time-table of public transport, risks of accidents).
(c) the costs and prices of infrastructure, vehicles and fuels.

The amount of effort (in terms of time, costs and/or other aspects) and (accident) risks related to the use of infrastructure and vehicles (transport supply) co-determines the volume and characteristics of travel and movement of goods (8), and creates opportunities for spatial interactions which can be measured by accessibility. The spatial distribution of accessibility co-determines location decisions of households and enterprises and results in changes of the land-use sy*stem* (9) (see Wegener and Fürst, 1999; LT *et al*., 1998);

Impacts
The functioning of the landuse transport system has impacts outside the system (10). The impacts can be viewed from three dimensions (see for example Serageldin, 1996; LT *et al*., 1998).

- the economic dimension, e.g. the accessibility of an area influences the economic activity in that area;
- the socio-cultural dimension, e.g. the landuse transport system can co-determine (a) equity aspects, e.g. distribution of costs, benefits and opportunities among groups of people or regions, (b) people's opportunities, e.g. the level of accessibility influences the number of social and economic opportunities people can take advantage of, (c) health and traffic safety, e.g. the spatial distribution of traffic influences people's exposure to emissions, noise and road, and (d) other social factors such as the level of social cohesion in a community or cultural identity;
- the ecological/environmental dimension, e.g. the landuse transport system has impacts on the number of natural resources, the global environment (e.g. greenhouse gas emissions) and the regional/local environment (e.g. noise and emission impacts on ecosystems).

These impacts interact to a certain degree with the contextual factors (11) and the development of policies aiming to changes the economic, ecological or social impacts of the landuse transport system (12).

2.3 Indicators used in recent Dutch transport scenario studies[3]

In the Netherlands, the RIVM, the Netherlands Bureau for Economic Policy Analysis (CPB), the Transport Research Centre (AVV) of the Ministry of Transport, Public Works and Water Management (AVV) and the Social and Cultural Planning Office (SCP) co-operate (along with other institutes and organisations) in the development and evaluation of national transport scenarios. Several national transport scenario studies have been recently published. The following studies will be described briefly in this section: (1) the Environmental Balance of 1998, (2) the evaluation of election programmes of Dutch political parties, (3) the Fourth National Environmental Outlook, (4) the OECD project on Environmentally Sustainable Transport (EST) and (5) the evaluation of Dutch public investment plans. For each of these studies the relevant indicators will be described, split into the following categories:

a) transport indicators:

[3] This section is an adapted version of the memorandum "Dutch transport and environment indicators" (Geurs *et al*., 1998)

- for the use of the transport system (e.g. vehicle use);
- for actual accessibility (e.g. travelling speed, travel time, congestion);
- for potential accessibility (e.g. number of jobs where the travel time is 45 minutes);

b) landuse indicators:
- for locations of activities (e.g. houses, enterprises);
- land coverage of transport infrastructure;

c) ecological/environmental indicators:
- energy use and (CO_2, NO_x and/or other) emissions from the use of vehicles;
- energy use and emissions from vehicle production, maintenance and scrapping;
- local aspects (noise, local air pollution);
- natural resources;
- liveability of urban areas;

a) economic indicators:
- macro-economic indicators (e.g. GDP, value added);
- external costs;

a) social indicators:
- equity aspects;
- access to opportunities;
- health and traffic safety;
- other.

The transport and land-use indicators are considered as intermediary indicators (i.e. necessary to calculate the environmental, economic and social impacts). Table 2.1 gives an overview of indicators per transport scenario study.

Environmental Balances from 1995 to 1998

Since 1995 the RIVM has published a yearly National Environmental Balance, which presents a quantitative analysis of the environmental quality for a historical time period (e.g. 1980-1997) and analyses the influence of governmental policies on the environmental quality. Also recently presented have been short-term forecasts of environmental quality. For example, the Environmental Balance 1998 described a short-term forecast for the period 1998-2002 (RIVM, 1998c). The relevant indicators used are:

(a) transport indicators, describing the transport volumes per vehicle category, e.g. vehicle kilometres, number of aircraft movements and
(b) environmental indicators, e.g. energy use and emissions from transport.

Election Programmes 1998

In spring 1998, the RIVM assessed the environmental effects of the election programmes of five political parties using "what-if" scenarios, i.e. what will be the effects on transport volumes and transport emissions by 2010 if all proposals of a political party are implemented (RIVM, 1998c)? Transport forecasts were constructed for the period 1997-2010. The following indicators are used:

(a) transport indicators, describing the forecasted transport volumes per vehicle category;
(b) environmental indicators, e.g. energy use and emissions from transport.

National Environmental Outlook 4 (NEO4) & Long-term economic forecasts (LT '97)

In 1997, the RIVM, CPB and AVV co-operated in a scenario study for the period 1995-2020. The CPB constructed three long-term economic scenarios (CPB, 1997a), which were used as input for passenger and freight transport forecasts from the AVV (AVV, 1997) and the fourth National Environmental Outlook (NEO4) (RIVM, 1997). For an English-language paper on NEO4 please refer to Van Wee *et al*. (1998). The NEO4 forecast emission levels and environmental quality in the Netherlands for the period 1995-2020, and offered solutions to the main environmental problems expected. The study resulting in the NEO4 was carried out with the intention to form the scientific basis for National Environmental Policy Plan 3 (NEPP3). Relevant indicators used are:
(a) transport indicators, describing the forecasted transport volumes per vehicle category (e.g. vehicle kilometres, number of aircraft movements) and the functioning of the transport system (e.g. vehicle hours lost in congestion);
(b) land-use indicators (i.e. locations of houses and enterprises, and the direct land-use of transport infrastructure);
(c) environmental indicators (e.g. energy use and emissions from transport).

Work is now (1999) in progress for the fifth Environmental Outlook, which will be published in the year 2000.

OECD project on Environmentally Sustainable Transport (EST)

In 1995, the OECD started a project "Environmentally Sustainable Transport" (EST) (OECD, 1996; OECD, 1998). Eight countries, Germany, Switzerland, Austria, France, Norway, Canada, Sweden and the Netherlands (specifically the RIVM) are conducting six pilot studies. These pilot studies sought answers to the following questions: What will the transport system look like if transport emissions are reduced by 80%-90% by 2030 (see Van Wee *et al*., 1996)? What are the policy instruments available and when will they have to be implemented to realise these sharp emission reductions (see Geurs & Van Wee, 1998)? What will the economic and social implications be of such a transport system (see Geurs & Adams, 1999)?

A "forecasting" business-as-usual transport scenario and three "backcasting" Environmentally Sustainable Transport scenarios were constructed in the EST project for the period 1990-2030, i.e.
(i) a "high-technology" scenario, containing only technological changes,
(ii) a "capacity-constraint" scenario, containing only mobility changes, and
(iii) a "combination" scenario, combining technological and mobility changes.

The indicators used to evaluate the transport scenarios are[4]:

(a) transport indicators, describing the forecasted transport volumes per vehicle category (e.g. vehicle kilometres, number of aircraft movements) and the functioning of the transport system (e.g. vehicle hours lost in congestion);
(b) landuse indicators, i.e. direct land use (e.g. land used for transport infrastructure) and indirect land use (e.g. land which cannot be used for activities such as living and working due to noise nuisance);
(c) environmental indicators, i.e. energy use and CO_2, NO_x, VOC and PM_{10} emissions from transport;
(d) economic indicators, i.e. changes in material welfare, like production value, final demand, value added, employment in directly affected sectors of the economy; and changes in non-material welfare or external costs that can be expressed in monetary values,
(e) social indicators, i.e. the distribution of wealth, social polarisation of access to social and economic opportunities, health and road safety, community relationships, crime and law enforcement, functioning of the government.

Evaluation of Dutch public investment plans (ICES in Dutch)

In summer 1997, the RIVM, along with the CPB, AVV and SCP, evaluated the economic, social and environmental impacts of public investment plans. These research institutes developed a general appraisal method to rank investment proposals either as: a) “a solid plan”, b) “possibly a solid plan but requiring improvements” (upgradable) or c) “a weak plan”. In addition, the research institutes estimated the effects of combining investment plans with complementary policy instruments like regulations and/or pricing instruments (CPB, 1997b; Annema *et al*., 1998). Transport forecasts were constructed for the period 1997-2010. The indicators used to evaluate the transport infrastructure plans are:

(a) transport indicators, describing the effects on road transport and public transport volumes as well as the functioning of the transport system (e.g. average travelling speed , vehicle hours lost in congestion);
(b) environmental indicators (e.g. energy use and emissions from transport);
(c) economic indicators (i.e. costs of time losses due to congestion).

[4] The economic and social indicators are used to compare the “combination” scenario to the business-as-usual scenario.

Table 2.1: Overview of indicators used in Dutch national transport scenario studies

	Environmental Balance	Election programmes	NEO4/ LT'97	EST	ICES
Transport indicators (intermediary)					
Car ownership		x	x	x	
Vehicle/passenger kilometres per mode	x	x	x	x	x
Tonne kilometres per mode	x		x	x	x
Number of air passengers	x	x	x	x	
Actual accessibility (e.g. travelling speed)			x		x
Potential accessibility					
Landuse indicators (intermediary)					
Land use (e.g. locations of houses, firms)			x	•	
Direct land use of infrastructure			x	x	
Indirect land use of infrastructure				x	
Ecological/environmental indicators					
Direct energy use per mode	x	x	x	x	x
Indirect energy use / emissions					
CO_2/ NO_x and/or other emissions per mode	x	x	x	x	x
Waste	x	x			
Natural resources					
Local air pollution			x	•	
Noise emissions / nuisance		x	x	•	x
Liveability of urban areas					
Economic indicators					
Macro-economic indicators (e.g. GDP, production value, employment)				x	
External costs – congestion				x	
External costs – other				x	x
Social indicators					
Equity aspects				•	
Access to opportunities				•	
Health and road safety				•	
Other (e.g. social cohesion, cultural identity)				•	

x = dealt with quantitatively
• = dealt with qualitatively

Table 2.1 shows the evaluations of Dutch transport scenarios described here to focus on "traditional" transport (i.e. vehicle use and actual accessibility indicators) and environmental indicators (i.e. energy use, emissions and noise from transport). In general, less attention is paid to landuse and (potential) accessibility indicators (e.g. access to social and economic opportunities for population groups), economic and social indicators. The OECD project on Environmentally Sustainable Transport (EST) represents a first attempt to use a more complete set of indicators for evaluating transport scenarios, including landuse, economic and social indicators. However, the EST project dealt with many indicators only qualitatively.

2.4 Discussion of research issues

In confronting the indicators used in recently published Dutch scenario evaluations (section 2.3) with the conceptual model for the landuse transport system (section 2.2) several research issues can be identified, i.e. ecological, economic, social or intermediary indicators, which have not or have insufficiently been addressed in the scenario evaluation. Here, the research issues will be shortly described. The amount of time and efforts necessary for a thorough analysis of all the research issues is much greater than can be managed within this research programme. Therefore only a selected number of research issues will be addressed in the research programme.

2.4.1 Ecological evaluations

The ecological/environmental evaluations of the Dutch transport scenarios include the environmental impacts of vehicle use (e.g. energy use, emissions, noise). However, there is little focus on:

(a) energy use and emissions due to production, maintenance and scrapping of vehicles and infrastructure, called the indirect energy use of transport. However, the indirect energy use and emissions from transport are significant (Bos, 1998; Bos & Moll, 1997).

(b) a broader analysis of the living quality/liveability aspects of urban areas, where several costs/impacts of the transport system are accumulated: e.g. environmental impacts of traffic (noise, odour, local air pollution), nuisance from moving and parked vehicles and visual aspects). Liveability aspects are also related to social aspects of transport.

2.4.2 Economic evaluations

In general, economic evaluations of specific transport projects, plans or policies usually involve a cost-benefit analysis of alternatives. In a social cost-benefit analysis, the economic, social and environmental changes as a result of the project, plan or policy are expressed in monetary units. From the evaluation of recent Dutch transport scenarios described in section 2.3, three research issues can be identified:

Firstly, a social cost-benefit analysis of alternative transport scenarios would ideally involve a comparison of internal costs (e.g. infrastructure costs for governments, vehicle use for individuals) and external costs (e.g. noise nuisance, air pollution, traffic accidents) with the internal benefits (e.g. increases in consumption and improvement in the standards of living, income and employment benefits, time and money savings, regional distribution of consumer goods and contribution to the division of labour - Ellwanger, 1995) and external benefits of the alternatives. However, none of the Dutch transport scenario studies described in Section 2.3 include such an assessment, although the evaluation of the Dutch public investment plans

(ICES) can be described as a – less detailed – social cost-benefit analysis. In literature, more elaborate examples of social-cost analysis of transport systems can be found. For example, Nelson (1997) estimated the total social costs and revenues of the Metropolitan Atlanta Rapid Transit Authority (MARTA) bus and rail system compared with the alternative car mode. It is estimated that between 1980-1994, the transit system generated more than 2 billion US dollars in net social cost savings (including direct revenues, internal user costs – taxes, travel times etc. and external costs – congestion, pollution and accidents) when car users switched to the transit system.

Secondly, benefits from the very *existence* of infrastructure have not been included in the social cost-benefit evaluations of the transport scenarios, whereas the benefits from the *use* of (improved) transport infrastructure have. However, infrastructure may have an "option value" if people or enterprises are willing to pay for the option of using the infrastructure in the future (see, for example, for a description of the option value concept: Johansson, 1991 and Pearce, 1991). More specific, infrastructure may have an impact on the entrepreneurial perceptions of a region's accessibility and the willingness in the future of an enterprise to invest or locate, and on the hedonic price of property values and recreational sites, and so forth (Lakshmann *et al.*, 1997). The "option value" of infrastructure is probably significant. For example, a study in San Francisco showed that the non-user benefits to residents living close to transit rail stations of the Bay Area Rapid Transit (BART) (i.e. time savings and higher willingness to pay for properties) accounted for up to 50% of the observed property value premium (Lewis-Workman & Brod, 1997).

Thirdly, current economic evaluation methodologies (e.g. social cost-benefit analysis) of transport scenarios are not very capable of handling the impacts of large changes in the transport system, which involve changes in the economic structure, whereas marginal changes can be handled well (see Rothengatter, 1998). For this reason, a System Dynamics model was developed for the economic evaluation of the "trend breach" transport scenarios for Germany developed within the OECD project on Environmentally Sustainable Transport (see also section 2.3).

2.4.3 Social evaluations

The evaluation of social-cultural impacts of transport scenarios in terms of equity issues, access to opportunities, public health, traffic safety, social cohesion or other social factors has received little attention in the evaluations of Dutch transport scenarios. Only within the OECD project on Environmentally Sustainable Transport project were these social impacts of transport scenarios explicitly – although only qualitatively – dealt with.

Examples of social evaluations from the literature on transport are usually related *to equity and fairness issues*, i.e. the effect of transport systems on social justice, in terms of who pays for transportation and who benefits. For example, Verhoef *et al*. (1996) studied the effects on and support for road pricing among different income groups. According to Lakshmann *et al.* (1997), the distribution of costs and benefits of transport among social groups, regions and sectors of the economy govern the real policy choices, and not the sum of costs and benefits. Thus, equity aspects of transport scenarios form an area needing more research.

The level of *access to opportunities* also seems to be an important research issue from a social point of view that is not dealt with in current Dutch transport scenario evaluations. Moreover, equity issues of transportation infrastructure in relation to accessibility constitute an area needing future research: differences in accessibility of opportunities (e.g. jobs) among groups of people (car owner vs. non-car owner) and differences among regions (e.g. peripheral areas with infrastructure provisions of low value vs. metropolitan areas with congestion problems).

The impacts of the transport system on *public health* (e.g. bonchitis and cancer risks caused by local air pollution) and *road safety* receive little attention in Dutch transport scenario evaluations, although they are relatively high. For example, the external costs of road traffic accidents account for 25-40% of the total external costs of road traffic (see Bleijenberg *et al*., 1994); health costs of local air pollution (i.e. particulate matter) account for a large share of the total external costs of road transport emissions, e.g. 15-45% for a 1990 petrol car, 80-90% for a diesel car (Dorland & Jansen, 1997).

2.4.4 Evaluation of intermediary indicators

In this report, transport and land-use indicators are considered intermediary indicators necessary to evaluate the ecological, economic and social impacts of the landuse transport system. Indicators describing the functioning of the transport system in terms of vehicle use and the actual accessibility (e.g. travelling speed, congestion) are dealt with adequately in current Dutch transport evaluation studies, whereas landuse and potential accessibility indicators have received little attention.

In the Dutch transport scenario evaluations described here (in Section 2.3), the link between land use and transport is dealt with on a one-way path, i.e. the impact of land use on transport. The impact of changes of the transport system on the locations of activities are currently not taken into account (i.e. impact of accessibility on location choices of people and enterprises). Inside and outside the Netherlands' transport models have been developed to handle the two-way interaction between land use and transport (AGV, 1995) . The incorporation of the transport-landuse interaction in transport scenario evaluations seems to be an important research issue as land use co-determines the ecological, economic and social impacts of the landuse transport system.

Neither are potential accessibility indicators – describing the number of destinations (offering opportunities) which can be reached by car, public transport or non-motorised modes within a certain travel time or distance – currently included in Dutch transport scenario evaluations. However, potential accessibility indicators can be relevant for the evaluation of economic and social impacts of the landuse transport system. Firstly, access to the (potential) working population possibly co-determines location choices of enterprises. Secondly, the potential accessibility of opportunities is related to the option value of the transport system (see Section 2.4.2). Thirdly, the distribution of accessibility of opportunities (jobs, shops, recreational sites, etc.) among different societal groups and regions can be a social issue, e.g. the number of jobs accessible within a certain travel time by public transport for low income groups in peripheral areas.

2.4.5 Integral evaluation of ecological, economic and social indicators

From the discussion of the current ecological, economic and social evaluation of Dutch transport scenarios, current Dutch studies evaluating transport scenarios can be concluded to focus on intermediary indicators (especially transport indicators) and ecological indicators. Moreover, a theoretically and methodologically founded framework for an integral assessment of the ecological, economic and social implications of future (alternative) transport systems is lacking. That such an integral evaluation is possible is shown by LT et al. (1998), who designed and applied a model system for analysing and providing forecasts of the interactions between land use, transport, the environment, the economy and social factors in urban areas. It also provides figures for environmental, economic and social indicators of urban sustainability.

3 Overview of the research programme

3.1 Introduction

This section presents an overview of the research programme, consisting of six phases as outlined below and shown schematically in Figure 4.1. The six phases of the programme are:

1. A review of existing literature on the relationships of the landuse transport system with ecology, economy and social factors.
2. A review of existing literature on methodologies for the ecological, economic and social evaluation of transport scenarios.
3. A review of evaluation methodologies used in existing scenario studies to identify “gaps” between methodologies used in current transport scenario evaluations and theoretically desirable methodologies (described in Phase 2).
4. The development of a methodology for the integral assessment of ecological, economic and social impacts of the landuse transport system.
5. The application of the methodology in case studies to assess the ecological, economic and social impacts of specific changes in the landuse transport system as a result of policy measures.
6. The writing of the final report (thesis).

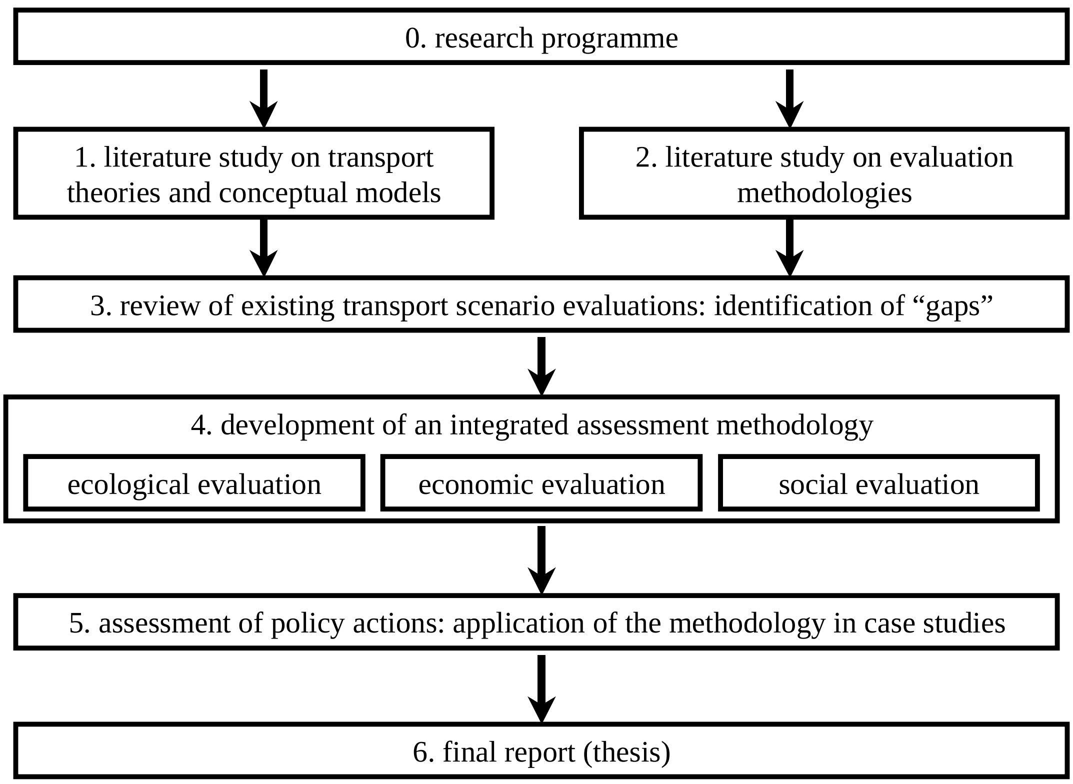

Figure 4.1: Schematic overview of the research programme.

Phases 0 to 3 - the preparation phase and the literature studies - are described in this section. The methodology development and application (Phase 4 and 5) is shortly described here and in more detail in sections 4 and 5.

3.2 Preparation phase (Phase 0)

Phase 0, the preparation phase, has resulted in this research programme. In the preparation phase, experts from several scientific fields (economists, transport economists, geographers, social scientists and transport engineers) inside and outside the Netherlands were asked to review the draft version of the research programme (see Appendix 1 for an overview of experts consulted). Furthermore, a paper outlining the research programme (see Geurs & Van Wee, 1999) was presented and discussed at the 1999 Dutch Transportation Planning Research Colloquium in Amsterdam.

The ***product*** of phase 1 is a final version of the research programme.

3.3 Literature study on the functioning and impacts of the landuse transport system (Phase 1)

This phase represents an assessment of the national and international literature on the functioning of the landuse transport system and its ecological, economic and social impacts. This phase is aimed at developing a conceptual model for explaining the interdependencies within the landuse transport system (e.g. the two-way interaction between land use and the transport system) and relationships with the ecological/environmental system (e.g. emissions, noise, energy use), the economic system (e.g. economic growth, economic structure) and the social system (e.g. equity aspects, health, traffic safety). This conceptual model will form an elaboration of the conceptual model described in section 2.2.

The model will form the basis for the review of methodologies used in existing scenario studies (Phase 3). A confrontation between the existing scenario evaluations and the conceptual model (Phase 1), and the evaluation methodologies found in literature (Phase 2), will result in the identification of “gaps” between current practice and (a) the desirable selection of indicators and (b) the desirable methodology for the evaluation of the selected indicators. The most relevant of these gaps in knowledge will be addressed in the methodology development (Phase 4).

The ***product*** of phase 3 is a 50-75 page report.

3.4 Literature study on evaluation methodologies (Phase 2)

This phase comprises a literature study on the theoretical and methodological aspects of transport scenario evaluations. This phase is, firstly, aimed at indicating which indicators are relevant for inclusion in the assessment methodology from a theoretical/methodological point of view, i.e. intermediary (transport and landuse indicators), ecological/environmental, economic and social indicators. Secondly, this phase is directed to discovering how these indicators can be estimated (including distribution among groups, regions and sectors) and integrated/aggregated.

A survey of national and international literature will be conducted on:

- criteria used for the selection of ecological, economic, social or intermediary indicators;
- evaluation methodologies for indicators:
  - transport indicators describing (a) the functioning of the landuse transport system: the use (e.g. vehicle kilometres, actual accessibility) and supply of the transport infrastructure, and (b) potential accessibility of spatially distributed opportunities;
  - landuse indicators describing (a) the relationship between the transport system, land use and locations of activities, and (b) direct and indirect land coverage of the transport system;
  - economic indicators describing the relationship between the transport system and the economic system (macro, micro). An example of a methodology is formed by the Dutch manual for the economic effects of infrastructure (V&W, 1996);
  - ecological/environmental indicators describing the relationships between the transport system and ecological/environmental impacts (e.g. emissions, noise, local air pollution). An example of a methodology is formed by the manual on strategic environmental assessment of infrastructure plans (DHV, 1999);
  - social indicators describing the relationships between the transport system and the social system (e.g. community relationships, differences between societal groups)
  - interdependencies between economic, environmental and social indicators;
- methodologies for the integration/aggregation of economic, environmental and social indicators, e.g.
  - monetary valuation: methodologies for assessing the internal costs and benefits (e.g. travel costs, travel time costs, infrastructure costs) and external costs and benefits of the landuse transport system. An overview of theories and methodologies for the economic valuation of environmental changes (e.g. hedonic pricing, contingent valuation, travel-cost methods) is given, for example, by De Boer *et al.* (1997);
  - multi-criteria analysis. An overview of different kinds of weighting methods is given by Nijkamp *et al.* (1990);

The ***product*** of phase 2 is a report of about 75 to100 pages.

3.5 Review of transport scenario evaluations (Phase 3)

This phase comprises a review of recent evaluations of transport scenarios. Both existing transport scenario studies and applications of impact assessment methodologies of (possible) transport systems or transport scenarios inside and outside the Netherlands are reviewed. The objective here is to indicate the methodologies for current evaluations of national and international transport scenarios. The review is also meant to describe the differences between the indicators used and the conceptual model (developed in Phase 1). Differences in current evaluations from the theoretically and methodologically desirable evaluation (derived from literature in Phase 2) will also be outlined. These differences will serve as input for the development of the assessment methodology for transport scenarios in Phase 4.

The transport scenario studies and impact assessments of (alternative) transport systems are reviewed under the following headings:

- the targets of the study;
- methodologies used for scenario construction:
    - ✓ forecasting vs. backcasting,
    - ✓ transport models used.
- geographical scope (local/regional/national/international);
- time horizon (base year/future years);
- indicators used to evaluate the scenarios, i.e. transport, environmental, landuse and economic indicators.
- the methodology used for estimating the indicators, i.e. transport, environmental, landuse and economic;
- the methodology used for the integration of the indicators, i.e. monetary valuation, multi-criteria analysis.

The ***product*** of phase 3 is a 75-100 page report reviewing recent transport scenarios.

3.6 Methodology development (Phase 4)

In this phase a methodology will be developed for the integral assessment of ecological, economic and social impacts of transport scenarios on the national/regional levels. The methodology will include primarily existing indicators and evaluation methodologies – used in current ecological, economic or social evaluations of transport scenarios – to assess a broad indicator set, this in contrast to a detailed assessment of one specific indicator. In addition, the integral assessment methodology will be elaborated by a limited number of indicators lacking in current transport scenario evaluations so as [OK?] to address the most important research issues. Section 4 gives a more elaborate description of the methodology development.

The ***product*** of this phase is a methodology and a report of about 100 pages describing how the methodology is built up.

3.7 Application of the methodology in case studies (Phase 5)

In this phase, the methodology developed in Phase 2 will be applied to case studies in which the ecological, economic and social impacts of transport scenarios, including the distribution of impacts among societal groups, economic sectors or geographical regions. Furthermore, within each case study the results of the integral assessment methodology will be compared to the results of the current scenario evaluations. The case studies will be closely related to similar RIVM projects. Section 5 gives a more elaborate description of the methodology development.

The ***product*** of this phase is a report of about 50 pages per case study.

3.8 Final report (Phase 6)

The ***product*** or thesis is, in effect, the final report of about 150-200 pages meant as a summary and discussion of the results of Phases 1 to 5.

4 Methodology development (Phase 4)

4.1 Objectives

The main objective of the methodology development for the integral evaluation of ecological, economic and social impacts of transport scenarios is:

To assess and forecast the long-term ecological, economic and social impacts of transport scenarios relevant to Dutch policy practice on the national level, assuming current or possible strategic policy actions.

The assessment methodology to be developed is *not* aimed at including all possible transport, ecological, economic, social and landuse indicators. However, it should represent a significant improvement compared to current Dutch transport scenario evaluations, which focus on “traditional” transport (i.e. vehicle and passenger kilometres) and environmental indicators (i.e. energy use, emissions and noise from transport) (see also section 2.3). The new elements or indicators introduced to the assessment methodology focus on developing a broad methodology (e.g. ecological as well as economic, and social and land-use indicators) rather than the addition of one indicator (e.g. economic) assessed in depth.

The methodology development will comprise two steps. The first step is to integrate existing evaluation methodologies from several scientific fields. This step is described in Section 4.2. The second step is to add new indicators or methodologies for existing indicators and is described in section 4.3.

4.2 Integration of existing methodologies

In the first step, current state-of-the-art methodologies are used for the assessment and forecasting of the selected intermediary (i.e. land-use and transport indicators), ecological, economic and social indicators (described in Phases 2 and 3).

The assessment methodology will be closely related to the transport and/or landuse models (Geographical Information Systems) already existing, i.e. the methodology will probably be used in or in combination with existing models. Relevant models are:

- the Dutch National model system for traffic and transport (NMS). This model estimates passenger transport volumes (car and public transport passenger kilometres) and road traffic levels on main road networks (HCG, 1997; Bovy *et al.*, 1992).

- the Scenario Explorer, a model for forecasting travel by land-based passenger transport modes in the Netherlands The model is partly a system dynamics model and partly a strategic model (Verroen, 1995);
- the Land Use Planner, a national spatial information system for the Netherlands, which forecasts future land use and inhabitants in detail (i.e. in an area of 500 x 500 m), based on the relationship between the number of inhabitants and jobs, the demand for space and the total amount of available space (Schotten *et al.*, 1997);
- the Environment Explorer, a land-use model for the Netherlands aimed at the evaluation of landuse changes in terms of the ecology, economy and people's valuation of their physical environment (RIVM, 1998b).

Furthermore, the methodology will be primarily based on existing data on a national or regional level. The main data sources will be:

- Statistics Netherlands (CBS), the Transport Research Centre (AVV) and RIVM for traffic and transport data;
- CBS and RIVM for environmental data;
- CBS and the Netherlands Bureau for Economic Policy Analysis (CPB) for economic data (i.e. split by region and economic sector);
- CBS and the Dutch Social and Cultural Planning Office (SCP) for socio-cultural data;
- CBS, the Dutch Spatial Planning Office (RPD) and RIVM for landuse data on a detailed scale (municipalities, postal digits), i.e. location and characteristics of land uses (houses, offices), location and characteristics of the population, households and enterprises.

4.3 Introduction of new elements

In the *second step* of the methodology development, new elements will be introduced to the integral assessment methodology to overcome the most relevant "gaps" between current methodologies for evaluation of transport scenarios and the theoretically/methodologically desirable methodologies – as identified in section 2.4. At the time of writing this research programme, investigation into the following issues seemed to be the most relevant: (1) accessibility indicators, (2) urban liveability indicators, (3) social indicators, and (4) land-use indicators. These elements are described below.

The development of new elements in the transport scenario evaluation methodology will be closely related to the planned and future research activities within the RIVM for the period 2000 to 2002. Therefore it is not possible to describe exactly what new elements will be introduced or what the level of detail of the analysis will be. At the moment of writing this report, the research activities are planned to start with the development of the accessibility indicators, whereas research on the other three issues described above will depend on the research activities in other RIVM projects (see section 7.1 for a short description of these projects).

4.3.1 Accessibility indicators

Current Dutch transport scenario evaluations include several actual accessibility indicators, whereas potential accessibility indicators receive little attention (see section 2.3). In this research programme, the objective of the (further) development of accessibility indicators is: *to select, develop and apply (actual and potential) accessibility indicators relevant for the ecological, economic and social evaluation of Dutch transport scenarios on the national level.*

The following questions are addressed:

1. How can accessibility be defined and operationalised, and which methodologies for estimating the accessibility of different types of opportunities are preferred from a theoretical/methodological and practical point of view?
2. How can the level of accessibility of opportunities by transport mode (i.e. car, public transport, non-motorised modes) be assessed and forecast for different societal groups and types of enterprises for different regions in the Netherlands?
3. How do individuals value the level of accessibility of different types of opportunities (e.g. work, school, recreation, nature areas, health services) by different modes (car, public transport, non-motorised modes), and (how) does it influence their travel behaviour and location choices?
4. How do entrepreneurs value the level of accessibility of the working population by different modes (car, public transport, non-motorised modes) and (how) does it influence their location choices?

The first two questions are methodological questions and will be addressed by using existing land-use and transport models and data described in the first step of the methodology development.

The last two questions will probably be addressed by conducting an empirical study to assess: (a) the relative influence of accessibility of different types of opportunities on travel behaviour and location choices of individuals and of enterprises, and (b) the “option value” of the transport system related to the level of potential accessibility. A data set will probably be constructed by means of a questionnaire to be sent out to individuals in several societal groups and region types, and to businesses/enterprises (from several sectors of the economy). The questionnaire will probably consist of a combination of revealed and stated preferences or choices.

4.3.2 Urban liveability indicators

In current Dutch transport scenario evaluations, traditional environmental indicators (e.g. energy use, emissions) are relatively well developed. However, little attention is paid to liveability aspects of the urban environment (see section 2.3). The objective of the development of (transport-related) urban liveability indicators in this research programme is: *to select, develop and apply transport-related urban liveability indicators relevant for the ecological, economic and social evaluation of Dutch transport scenarios on the national level.*

The following research questions are to be addressed to meet the objective:

1. How can urban liveability indicators be defined and operationalised, and which methodologies for estimating these indicators are preferred from a theoretical/methodological and practical point of view?
2. How do individuals value transport related aspects of urban liveability (e.g. the level of traffic, the number of parked vehicles, (perceived) traffic safety, noise and odour nuisance)?

The first question is a methodological one, which will probably be addressed by using existing landuse and transport models, and data described in the first step of the methodology development. The last question will probably involve an empirical study to assess the relative importance of transport-related aspects of urban liveability.

4.3.3 Social indicators

In current Dutch transport scenario evaluations, social indicators have received little attention. The objective of the development of social indicators in this research programme is: *to select, develop and apply indicators relevant to the social evaluation of Dutch transport scenarios at the national level.*

The following research question is to be addressed:
How can social indicators be defined and operationalised, and which methodologies for analysing these indicators are preferred from a theoretical/methodological and practical point of view?

Some social indicators can probably be dealt with using existing methodologies and data (see section 4.3.1) or are related to the accessibility and urban liveability indicators which are planned to be developed in an earlier stage (see section 4.3.1 and 4.3.2), i.e. equity aspects related to the level of access to opportunities, health and traffic safety. Other social factors, which are relevant from a sociological perspective (e.g. social cohesion, cultural identity), can probably only be assessed in a qualitative manner, probably by conducting a Delphi type of study.

4.3.4 Land-use indicators

In current Dutch transport scenario evaluations, the land-use impacts of transport changes are not dealt with. This research issue is relevant here because the land-use changes as a result of changes in the transport system co-determine the ecological, economic and social impacts. However, it is expected that the effort involved in a thorough analysis of the land-use impacts is much larger than what can be handled within the scope of this research programme. This research issue will only be addressed if this is planned within the framework of other RIVM projects (see Section 7.1).

5 Case studies (Phase 5)

In this phase, the integral assessment methodology developed in the preceding phase will be applied to case studies to assess the ecological, economic and social impacts of changes within the landuse transport system as a result of policy actions. In contrast to the current transport scenario evaluations, the following elements are to be introduced:

- an assessment and forecast of the landuse impacts of the transport system;
- an assessment and forecast of a broad spectrum of ecological, economic and social impacts in the continuation of current trends;
- and assessment and forecast of changes in accessibility of different types of opportunities by transport mode, distributed among societal groups, regions and economic sectors;
- an assessment and forecast of expected social impacts (e.g. health, safety, community relationships);

Within each case study the results of the integral assessment methodology will be compared to the results of the current scenario evaluations.

The case studies will be closely related to RIVM projects conducted within the time frame of this phase (i.e. the year 2002). Therefore, it is not possible in this research programme to describe exactly which case studies will be conducted. However, at the moment the following case studies would seem relevant:

Case study 1: Business-as-usual transport system

The development of a business-as-usual scenario will be used to forecast the long-term ecological, economic and social impacts of business-as-usual transport policies. The impacts of the business-as-usual scenario will serve as a reference scenario for the assessment of impacts of specific infrastructure changes (in the following case studies). This case study represents an elaboration of current evaluations of business-as-usual transport scenarios (such as the Dutch National Environmental Outlooks – see section 2.2), which are currently focused on transport and environmental indicators.

Case study 2: Effects of infrastructural changes

Here, the ecological, economic and social impacts of infrastructure policies (e.g. the impacts of the introduction of a high-speed rail system for passenger transport, light rail systems or road infrastructure expansions) are analysed. This case study elaborates on the evaluation of Dutch public investment plans (ICES in Dutch), which was carried out by the RIVM, the AVV, the CPB and the SCP in 1997.

Case study 3: Environmentally sustainable transport system

- Here, the landuse, ecological, economic and social impacts of an alternative transport system that meets heavy reductions in emissions will be assessed. This case study is an elaboration of the OECD project “Environmentally Sustainable Transport” (EST), in which the economic and social impacts of a “backcasting” environmentally sustainable transport scenario for the period 1990-2030 are analysed – compared to a business-as-usual scenario - and a which meets emission reductions of 80-90% for the period 1990-2030 – (see section 2.2). In contrast to the EST project, new elements will probably include:

- an assessment and forecast of the landuse changes of an environmentally sustainable transport system;
- changes in accessibility of different types of opportunities by transport mode, distributed among societal groups, regions and economic sectors;
- an assessment and forecast of the economic impacts of an environmentally sustainable transport system. The economic impact assessment represents an analysis of large changes in the transport system and includes the analysis of changes in the economic structure (i.e. changes between regions and economic sectors).

6 Time frame & Planning

Some of the project phases will be conducted simultaneously. The planning for the project phases is as follows:

- Phase 0: research programme and expert review: July 1999 - December 1999
- Phase 1: literature study on conceptual models: December 1999 - December 2000
- Phase 2: literature study on methodologies: December 1999 - December 2000
- Phase 3: scenario review: December 1999 - December 2000
- Phase 4: methodology development: January 2000 - March 2002
- Phase 5: case studies: April 2002 - April 2003
- Phase 6: final report: May 2003 - December 2003

7 Links with RIVM projects and other organisations

7.1 Links with current or planned RIVM projects

At the time of writing this report, several RIVM projects which are relevant for the execution of this research programme, and for which co-operation will be sought, were either being conducted or planned. Relevant RIVM projects are:

- the development of an urban sustainability model, aiming to enable an integral evaluation of factors influencing the urban setting, including (a) physical characteristics of the urban setting (e.g. the location of houses and other buildings, transport infrastructure, green spots), (b) characteristics of the population (e.g. age and household composition, income distribution), (c) characteristics related to the spatial distribution of activities, (d) people's perception of and health aspects related to the urban environment (e.g. noise nuisance, liveability aspects) At the moment of writing, a prototype of the model is developed;
- the further development of the Environment Explorer (see RIVM, 1998b). The Environment Explorer is a landuse model for the Netherlands aimed at the evaluation of landuse changes in terms of the ecology, economy and people's valuation of the physical environment. At the time of writing, the elaboration of the Environment Explorer with a landuse transport interaction model was being discussed.
- the further development of the Land Use Planner (see Schotten *et al.*, 1997). The Land Use Planner is a spatial information system for the Netherlands, which forecasts future land use in detail (i.e. in an area of 500 by 500 m). At the time of writing, the Land Use Planner was being elaborated with the possibility of forecasting the number of inhabitants and households per area, based on location characteristics (e.g. distance to road and rail infrastructure, distance to urban areas), their demand for space and the total amount of available space (see Goetgeluk *et al.*, in press);
- the development of accessibility indicators for health services. Within the Public Health divisions of the RIVM, (potential) accessibility indicators of (different types of) health services are being investigated (see, for example, Kalisvaart, 1998).

7.2 Links with other organisations and institutes

This section gives an overview of the most important centres and institutions involved in evaluations of transport systems/scenarios in the Netherlands, and relevant international organisations. The RIVM intends to conduct the research programme in co-operation with these organisations.

Transport Research Centre (AVV)

The Transport Research Centre of the Dutch Ministry of Public Works, Water Management and Transport (AVV) plays an important role in the evaluation of transport scenarios in the Netherlands. Firstly, the AVV conducts evaluations of transport policies and scenarios. Evaluations of passenger transport scenarios are based mainly on the National Model System for Traffic and Transport (HCG, 1997; Bovy *et al*., 1992), which forecasts passenger transport volumes (car and public transport passenger kilometres), road traffic levels and level-of-service of the main road network. Secondly, the AVV initiates research for the improvement of evaluation methodologies.

Netherlands Bureau for Economic Policy Analysis (CPB)

The Netherlands Bureau for Economic Policy Analysis (CPB) is involved in the evaluation of economic impacts of governmental policies. The CPB, which uses macro-economic models to forecast short-term and long-term economic developments, has been involved in several studies in which the economic impacts of transport scenarios or changes in the transport system are assessed.

Utrecht University, Faculty of Geographical Sciences

The Faculty of Geographical Sciences of Utrecht University is a leading centre of expertise in the Netherlands for geographical research and geographical information systems. Relevant projects are related to the relationships between land use, transport and the environment. Several studies have been conducted on the accessibility of housing and working locations using Geographical Information Systems. The Utrecht University co-operates with the Universities of Amsterdam, Delft and Eindhoven within the Netherlands Graduate School of Housing and Urban Research (NETHUR), whose central field of interest is urban dynamics and housing.

Free University Amsterdam, Department of Regional Economics

The Department of Regional Economics of the Free University Amsterdam (VU) is a leading centre of expertise for spatial economics. This Department uses a theoretical, methodological/modelling and/or policy-analytic approach. Relevant projects are related to economic evaluations in the transport sector. The Free University Amsterdam co-operates with the University of Amsterdam (UvA) and the Erasmus University Rotterdam (EUR) within the Netherlands Research Institute and Graduate School of Economics (Tinbergen Institute); the latter stimulates fundamental and applied economic research.

Organisation for Economic Co-operation and Development (OECD)
The OECD and associated institutions (International Energy Agency- IEA, European Conference of Ministers of Transport – ECMT) are involved in environmental as well as economic evaluations for the transport sector. Relevant projects are related to the social costs of transport (external costs) and scenario studies on environmentally sustainable transport; projects are conducted in co-operation with several OECD member countries.

European Union – DGVII/DGXI
The Directorate-Generals of Transport (DGVII) and of the Environment (DGXI) commission transport and environmental studies deemed relevant from a European perspective. In 1998, a project started – in co-operation with the European Environmental Agency and Eurostat – in which a conceptual framework for the analysis of transport and environmental indicators is being developed. This project is aimed at contributing to a better integration of environmental concerns into transport policies and decision-making.

There are other research institutes and organisations, as well as many consultants in the Netherlands not mentioned here, which are, or have been, involved in evaluations of possible landuse transport systems, transport systems or scenarios.

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Appendix 1 Mailing list

1. Director Noise and Traffic of Directorate-General for Environmental Protection
2. Dep. Director Directorate-General for Environmental Protection, Dr. Ir. B.C.J. Zoeteman

3. Prof. Dr. G.P. van Wee – UU/RIVM
4. Prof. Dr. P. Nijkamp - VU
5. Prof. Dr. P. Rietveld - VU
6. Prof. Dr. P.H.L. Bovy - TUD
7. Prof. Dr. A.I.J.M. van der Hoorn - UvA/AVV
8. Prof. Drs. J.G. de Wit – UvA
9. Prof. Dr. M.F.A.M. van Maarseveen - UT
10. Prof. Ir. F. le Clercq – UvA/Twynstra Gudde
11. Prof. Dr. C.A.J. Vlek – Universiteit Groningen – COV
12. Prof. Dr. Ir. H. Priemus – TU Delft
13. Prof. Dr. P.A. Steenbrink – KUN
14. Prof. Dr. Eng. Y. Hayashi - Nagoya University Japan
15. Prof. Dr. J. Adams - University College London
16. Prof. Dr. D. Banister – University College London, Bartlett School of Planning
17. Prof. Dr. W. Rothengatter - Universität Karlsruhe
18. Prof. Dr.-Ing. M. Wegener – Universität Dortmund, IRPUD
19. Prof. Dr. F. Ramjerdi - Royal Institute of Technology, Sweden

20. Drs. H.C.G.M. Brouwer – Ministerie van VROM/DGM
21. Ir. J.J.M. Henssen - Ministerie van VROM/DGM
22. Mr. M.C. Kroon - Ministerie van VROM/DGM
23. Drs. H. ten Velde – Ministerie van VROM/RPD
24. Drs. B. van Bleek – Ministerie van VROM/RPD
25. Drs. R. Dooms – Ministerie van EZ
26. Drs. J.K. Hensems – Ministerie van EZ

27. Ir. J. van der Waard – AVV
28. Dr. N. Kalfs – AVV
29. Drs. F.A. Rosenberg – AVV
30. Drs. T.H. van Hoek – CPB
31. Drs. C.J.J. Eigenraam - CPB
32. Dr. C.C. Koopmans – CPB
33. Ir. E. Verroen – TNO Inro
34. Drs. Ing. P.M. Blok – NEA

35. Dr. N. Verster – NEI
36. Dr. M. Dijst – UU
37. Dr. J. Ritsema van Eck – UU
38. Dr. T.J.M. Spit – UU
39. Depot Nederlandse Publicaties en Nederlandse Bibliografie

40. Dr. P. Wiederkehr - Environment Directorate, OECD, Paris
41. Mr. R. Thaler - Federal Ministry for the Environment, Austria
42. Ms. H. Verron - Umweltbundesamt Berlin, Germany
43. Ms. E.M. Åsen - Ministry of the Environment, Norway
44. Mr. S. Anderson - Swedish Environmental Protection Agency, Sweden
45. Mr. H. Jenk - Federal Office of Environment, Forests & Landscape
46. Mr. R. Gilbert - Centre for Sustainable Transport, Canada
47. Dr. G. Hörmandinger – European Union, Directorate-General XI (Environment)

48. Directie RIVM
49. Ir. F. Langeweg – SB5
50. Dr. J.A. Hoekstra - LAE
51. Dr. M. Kuijpers-Linde - LAE
52. Dr. Th. Aalbers - LAE
53. Drs. J.A. Annema – LAE
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56. Ir. P.F.L. Feimann – LAE
57. Drs. J. Ros – LAE
58. Dr. R. Goetgeluk - LBG
59. Drs. J.A.M. Borsboom-van Beurden – LBG
60. Drs. R.J.M. Maas – MNV
61. Drs. W. Lammers - MNV
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63. Dr. E. Drissen – MNV
64. Dr. Ir. J. Notenboom - ECO
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71. Bibliotheek RIVM
72. Bureau Rapportenregistratie

73-98. Rapportenbeheer

99-125. Reserve-exemplaren

Appendix 2 List of experts consulted

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- Prof. Dr. J. Adams - University College London
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