FINAL PUBLISHABLE REPORT

CONTRACT N°: GMA2-2001-52051-S07.15431

ACRONYM: POET

TITLE: Prediction Of e-Economy impacts on Transport

PROJECT CO-ORDINATOR: Stichting RAND Europe, The Netherlands

PARTNERS:

Transek, Sweden
ITS Leeds, UK
ARPA, Italy
Hebrew University Jerusalem, Israel
PROODOS, Greece
Kessel + Partner, Germany
TRAIL, Netherlands
Solving International, UK

REPORTING PERIOD: **FROM** 11 December 2002 **TO** 10 May 2005
PROJECT START DATE: 11 December 2002 **DURATION:** 29 months
Date of issue of this report: 10 May 2005

Project funded by the European Community under the 'Competitive and Sustainable Growth' Programme (1998-2002)

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1. Executive publishable summary

Objective: The overarching goal of POET is to understand the potential impacts of the e-Economy on the future demand for passenger and freight transport in cities and regions and the opportunities presented by this digital revolution for improving the quality of life of Europe's citizens by enhancing accessibility and by mitigating the adverse impacts the e-Economy could have on urban transport.

Work performed: During the project, the consortium performed the following tasks:

- An extensive literature review on the impact of the e-Economy on transport (WP2);
- A survey of industry experts on logistics and freight distribution and transport (WP2);
- Development of a system diagram and choice profiles for passenger and freight transport (WP3);
- Development of three scenarios to better understand the future impact of the e-Economy on transport (WP3),
- Eleven actual case studies to gain an insight in the future uptake of ICT-applications, such as teleworking, electronic auctioning, and intelligent transport systems, and the transport consequences thereof (WP4).
- Collection of stated preference data on the choice behaviour of businesses, households and individuals under different future scenarios that may impact passenger and freight transport in 2010 (WP5).
- Modelled the impact of the e-Economy on transport for five urban areas (WP6).

Achievements to date: The study has provided important insights in the wide variety of ways in which the e-Economy may impact on both passenger and freight transport. As existing knowledge about the nature and magnitude of the impacts of the e-Economy on transport turned out to be limited, we have gathered additional information (actual case studies, virtual case studies and urban models) to deepen and broaden the available knowledge on the issue at stake. Although our study does not give an answer to all questions, we made a big step forward in understanding the impact of the e-Economy on transport.

End results: The studies presented in the literature review provide limited evidence to support the hypothesis that e-Economy developments lead to less transport. The actual case studies, on the other hand, identified some clear examples of cases in which ICT-applications have led to a reduction in vehicle kilometres. However, it needs to be stressed that the actual case studies were not selected at random, that these may include best practices regarding the uptake of ICT-applications, and that the

results of the actual case studies cannot easily be generalised. To get a more representative view on the impact of specific e-Economy developments (such as teleworking and e-shopping for passenger transport, and e-shopping and tracking & tracing for freight transport), the virtual case studies were conducted. The virtual case studies indicate that developments in the e-Economy will affect the choice behaviour of businesses, households, and individuals. They do, for example, show that both companies and individuals expect that teleworking will be somewhat more common in 2010, that people will more frequently buy products over the Internet, and that companies will make increasing use of tracking & tracing technology. The modelling of the impact of the e-Economy on transport in a number of selected urban areas in Europe shows that e-Economy developments are expected to lead to reductions in passenger kilometres between 2004 and 2010 in all urban areas studied. However, the number of vehicle kilometres related to freight transport by road is expected to increase by a few percent because of the e-Economy developments.

Intentions for use of the end results: The knowledge and insights resulting from the POET-project contribute to the formulation of effective policies in the domains of transport, information society and possibly other domains (e.g. spatial planning and environmental policy). The project results will thus be disseminated among the appropriate policy making and research communities. The results of the POET-project are in the public domain and no protection of results is envisioned. We envision that the results of the projects will be used in the following ways:

- To support policy making in the field of information and communication technology;
- To support policy making in the field of passenger and freight transport; and
- To make scientific progress by enhancing the understanding of the relationship between developments in the e-Economy and transport.

The targeted audiences of the project results thus include policy makers in different policy domains (e.g. information society, transport, and spatial planning) and at different levels of government (EU, national, regional and local level). In addition, the academic world is one of the target audiences of the POET-project as the project is providing new insights regarding the relationship between developments in the e-Economy and passenger and freight transport, and will generate recommendations for further research.

2. Objectives of the project

The overarching goal of POET is to understand the potential impacts of the e-Economy on the future demand for passenger and freight transport in cities and regions, and the opportunities presented by this digital revolution for improving the quality of life of Europe's citizens by enhancing accessibility and by mitigating the adverse impacts the e-Economy could have on urban transport. To achieve this, POET will:

- Understand the choices and factors that are relevant for and affect the demand and supply of passenger and freight transport in urban areas (cities and regions);
- Provide more insight in how the e-Economy could change how individuals, households, and organisations make decisions regarding, for example, their need to travel, and how to use the transport system;
- Model the impact of the e-Economy on urban transport and traffic flows (mode share, temporal distribution of trips, energy use and other environmental impacts) and the resulting impacts on energy use, emissions, social exclusions, and the competitiveness of cities and regions.

POET contributes to the **socio-economic objectives of sustainability and enhanced efficiency and quality** of Key Action 2, "Sustainable Mobility and Intermodality" by:

- Identifying and understanding the key decision points and issues for modal choices for the movement of passengers and freight, and how these choices can change in the future with the development of the e-Economy;
- Identifying opportunities in the e-Economy to improve the quality and functioning of the transport system, particularly in cities, and thereby contribute to the objective of sustainable cities by promoting equity, social cohesion and reducing congestion, emissions and other adverse environmental impacts of transport.

POET contributes to the **research objectives** of Key Action 2 "Sustainable Mobility and Intermodality" by:

- Supporting the objectives of paragraph 2.1.2, "Driving forces in transport." Identifying and understanding the key decision points and issues affecting mode choice and studying how these will change in response to developments in the e-Economy, provide this support;
- Supporting the objectives of paragraph 2.2.2, "Environment." This support is provided by providing a transparent and coherent framework for quantitatively estimating the size and impacts of developments in the e-Economy on modal share of different transport modes. This, in turn, will support policymaking and evaluation.

3. Scientific and technical description of the results

3.1 Critical overview

The work in POET is divided into seven work packages, each producing one or more deliverables.

Table 1 Overview of the POET-project

WP	Brief description of the nature of the WP	Deliverables related to the WP
WP1	Project management and co-ordination	D1 – Inception report D5 – Input for e-Europe initiative
WP2	State of the art review	D2 – State of the art review
WP3	Framework for studying the e-Economy and its transport consequences	D3 – System diagrams and choice profiles D4 – Scenarios[1]
WP4	Actual case studies of passenger and freight transport	D6 – Selection of cases and plans for carrying out actual case studies D7 – Results from actual case studies
WP5	Virtual case studies of passenger and freight transport	D8 – Selection of cases and plans for carrying out virtual case studies D9 – Results from virtual case studies
WP6	Modelling the impacts of the e-Economy on transport in cities and regions	D10 – Results of six case studies on urban transport
WP7	Dissemination of results	D11 – Plans for creating and maintaining the project website D12 – Plans for creating and distributing project newsletter D13 – A brochure describing main results of the study

In this section we will not discuss WP1 and WP7. WP1 is discussed in Chapter 7 of this report, and WP7 is discussed in the Technological Implementation Plan that is submitted to the European Commission parallel to the current report. All work packages are now completed. Below the main results of each of the work packages are summarised.

[1] In the inception report, we had indicated that we would provide a D3 on the system diagrams and the scenarios and a D4 on the choice profiles. During the course of the project, it turned out to be more logical to combine the work on the system diagram with the work on the choice profiles. Therefore the results of these tasks are presented in one deliverable (D3). The work on the scenarios is presented in another deliverable (D4). This change was proposed to and accepted by the European Commission.

3.1.1 WP2 – State of the art review

The objective for WP2, as stated in D1 - Inception Report, was: "to conduct a comprehensive State-of-the-Art review that covers the literature on various aspects through which the e-Economy affects transport: travel, activity patterns and land use; urban freight distribution concepts and relevant logistics and supply chain developments; technological developments relevant for the transport sector and global trends. In addition a glossary of relevant terms has been composed. The outcome of this WP was the identification of existing trends that drive the future transport system and, where data are available, an assessment of the size of the impact. The state-of-the-art review was divided into four parts covering trends with a potentially large impact on passenger and freight transport, namely (1) technological developments; (2) forces driving structural change; (3) potential impacts on passenger travel; and (4) potential impacts on freight travel. The main results of the state-of-the-art review are discussed below.

Part I: Technological developments. In considering the potential impact of the e-Economy, the availability of bandwidth is extremely important. Higher bandwidth enables faster communication and information exchange. Important technologies providing an increasing number of people with access to more bandwidth include ISDN, ADSL, and ATM. New technologies for high-speed mobile communication such as WAP and Bluetooth, are making it increasingly easy to access this bandwidth from mobile locations. Furthermore, developments in encryption, identification, authentication and verification technologies are increasing people's trust in the safety of transactions carried out over the Internet. Increased bandwidth and its accessibility in a safe and secure way enable the substitution of physical presence and face-to-face transactions with a virtual presence and transactions carried out over the Internet.

The availability of more bandwidth makes it possible to provide travellers with real time information, such as traffic and congestion conditions, which contribute to making transport more efficient and safe. Clearly, the potential for the above technologies to have a large impact is there. Whether or not this potential is realised depends on how rapidly and to what extent these technologies are accepted by people and incorporated into their lifestyles, work and leisure.

Part II: Forces Driving Structural Change (FDSCs). There are several economic, demographic, political and societal trends that are relevant for the future demand for both passenger and freight transport. For passenger transport the trends in the spatial (e.g. suburbanisation) and demographic (e.g. ageing of the population) distribution of the population are important. Equally important for the future demand for passenger transport are the societal and individual attitudes towards the environment, consumption, work and leisure.

In terms of freight transport, probably the most important trends are the declining share of industry in the GDP of European economies, the increasing contribution of the service sector to GDP, the increasing value to weight ratio of inputs and products in the knowledge intensive industries (for example, the computer, bio-tech and fine chemical industries) and the increasing geographical concentration of industry (the so-called clustering of industries). In addition to these economic trends, changes in production techniques, such as the widespread use of just-in-time production systems, and logistics systems, such as value added logistics, are changing the way freight is transported.

Part III: Potential impacts on passenger travel. The potential impacts of the e-Economy on transport and travel were studied by reviewing literature on:

- Consumer purchase behaviour (e-commerce, online shopping, e-ticketing);
- Usage of teleservices (e-reservations, travel information acquisition, etc.);
- Work-related arrangements (tele-commuting, mobile working, etc.); and
- Travel-related activities (effect of intelligent transport systems such as Advanced Traveller Information Systems and Advanced Public Transportation Systems and information provision on travel response such as route, departure time, mode, etc.).

Although the body of literature studying the effects of ICT on passenger transport is quite extensive, no definite conclusions regarding the impact of ICT on passenger transport can be drawn as current research has relied on incomplete information regarding traveller choice behaviour, has employed convenient samples, etc.

Part IV: Potential impacts on freight travel. The impact of developments in the e-Economy on freight transport has been dramatic. The literature suggests that the primary impact of these developments has been to re-structure the production and logistics chain. The thrust of this restructuring has been to make production more responsive to customer needs by reducing both the time from the moment an order is placed to the moment of customer delivery, and the cost of delivering the final product to customers. Fast, efficient, responsive, and reliable supply chains have also led to observable changes in the spatial concentration of production and manufacturing activities, and the centralisation of inventories. The combined effects of increased customisation of products to customer needs, shorter lead times in both manufacturing and retailing, outsourcing of logistics activities is leading to large volumes of freight being shipped between the production and distribution centres on a European and Global scale, but smaller volumes being shipped more frequently at the national, regional and local scale. However, the net effect of all these developments on the total volume of transport is still not known with any degree of certainty.

Results of the industry panel. As part of WP2, we also organised a survey of industry experts on logistics and freight transport in order to better understand the general trends and impacts of the e-Economy on freight transport. Forty logistic managers were interviewed for their opinions about 'E'. They agreed that e-Economy is not the driving force behind the changes in freight transport. This survey showed that, taking all impacts into consideration, nearly three quarters of all respondents foresee a (significant) growth in freight transport and only 11% predict a decrease. Businesses are primarily focussed on delivering value to their customers and stakeholders. Transport efficiency and the impacts on the environment are not always recognised as being a priority in delivering company results. As one member of the industry panel suggested, "legislation will have a role to play in encouraging companies to adopt e-technology that supports efficient and environmentally friendly transport systems".

Summary of main points. The literature review suggests that the e-Economy has the potential to significantly affect the overall demand for passenger and freight transport, as well as attributes of this demand. In terms of the overall demand, developments in the e-Economy have the potential to both increase and reduce demand. Consider the example of e-Shopping. This can increase the demand for freight as increasingly demanding customers want immediate delivery of their purchases, resulting in lower load factors and more trips. On the other hand, e-Shopping results in fewer shopping trips. Thus, there is a substitution of passenger transport by freight transport. The net effect on total transport, however, remains unclear. The results of both the literature review and the industry expert panel are discussed in detail in D2. The Deliverable was reviewed and has been accepted by the European Commission.

3.1.2 WP3 – Framework for studying the e-Economy

The objectives for WP3, as stated in the Inception Report, are the:

- Development of system diagram(s) to describe all factors relevant for understanding the impacts of the e-Economy on transport;
- Analysis of choice profiles of key actors that make decisions affecting the e-Economy and transport;
- Development of scenarios describing different potential futures focusing on those developments that have implications for the impact of the e-Economy on transport;
- Validation of the findings by means of a workshop.

The results of this work package are reported in two deliverables: D3 reports on the development of the system diagrams and choice profiles, and D4 reports on the scenarios, which were developed as part of the project. These deliverables are summarised below.

System diagrams and choice profiles. The system diagram was developed using a step-by-step approach, starting with identifying the Forces Driving Structural Change (including developments in the e-Economy) in the transport system, the choices made by relevant actors within the system and the outcomes of interest. The objective of the system diagrams was not to define the system to a level of detail that would make it suitable for modelling purposes, but to incorporate a level of detail that allows for understanding the complex relationship between e-Economy developments and transport.

Research objectives. Our primary objective in developing the theoretical framework was to provide insights into the factors that influence the functioning of the passenger and freight transport systems, and thus the outcomes resulting from the functioning of these systems. More specifically, the theoretical framework was developed to gain an understanding of: (a) the current structure of the passenger and freight transport system; (b) the choices governments, businesses, households, and individuals make regarding transport; (c) the factors influencing the choice-making behaviour of these actors; and (d) the potential role of ICT in changing this behaviour.

Research methodology. To better understand the way in which the e-Economy may affect passenger and freight transport, we have constructed a framework that describes the main elements of the transport system. The framework is an artificial, and incomplete representation of the system being studied, but it is nevertheless a useful device to employ in studying an issue (and the underlying system) that is not well understood. The framework consists of a separate system diagram and choice profiles for passenger and freight transport. The primary reason for having separate system diagrams is the large differences in the functioning of the passenger and freight transport systems, such as differences in the primary actors making choices, in the number of actors involved in those choices, and the type of choices made.

System diagram for passenger transport and choice profiles. The system diagram for passenger transport is intended to help us understand how developments in the e-Economy can affect the choices of households and individuals regarding where they live and work, shop and learn. The system can be seen as a series of three markets in which the desires of households and individuals (i.e. the demand side) are confronted with the opportunities offered to them (i.e. the supply side). On the left side of the diagram, households and individuals have lifestyle preferences and attitudes that determine how they would like to live their lives, i.e. what kind of activities they would like to undertake, and how often, when and where they want to undertake these activities. The same households and individuals are however limited by the opportunities that are presented to them, i.e. by the actual spatial planning, the available ICT-infrastructure, and the opening hours of offices, shops, leisure facilities, etc. As a consequence, households and individuals have to make choices regarding their location of residence, location of work, car ownership, acquisition of goods and services, and access to education opportunities, taking into account the actual opportunities. When

households and individuals have taken a decision regarding their residential location and the location and timing of their activities, the choice is further restricted by the available transport infrastructure, the available level of service for all transport modes, and the availability of ICT-networks. Based on this information, households and individuals first determine the timing and scheduling of their activities, resulting in a chosen activity set, and then make decisions regarding the mode with which they travel and the route they take. The combined decisions of all households and individuals result in a set of traffic patterns, with associated transport, environmental, economic, and social outcomes. The important choices (for passenger transport) made by households and individuals include :

- Choice of residence location;
- Car ownership choice;
- Choice of location of work;
- Decision to acquire goods and services;
- Decision to access educational opportunities;
- Choice of activity timing and scheduling;
- Choice of mode/e-mode;
- Choice of route.

Freight system diagram and choice profiles. In developing the system diagram for freight transport (see Annex A) we distinguished three types of freight flows: (1) Type 1: Downstream distribution flows; (2) Type 2: Upstream supply flows; and (3) Type 3: Return flows. In addition, we distinguished two trips: (1) Trip 1: A consolidated flow that usually occurs between major sea ports or manufacturing sites at one end and distribution facilities at the other end; (2) Trip 2: A distribution flow that usually occurs, in the metropolitan/urban area, between the distribution facility at one end and the final delivery location at the other hand. For practical reasons, POET focuses on the type-1 flows (downstream distribution flows) and within these flows on trip 2 transport flows within the metropolitan areas.

The decisions regarding freight transport can be placed in three markets: (a) the market for distribution locations; (b) the market for distribution networks; and (c) the market for distribution traffic. In each of these markets, the demand and supply meet and help determine the nature of freight flows. Together, these three markets could be termed a *distribution structure*. Elements that are determined through the logistics concept include: the location of distribution facilities, choice of mode, the choice of equipment, scheduling and planning strategy (resulting in a preferred volume/frequency balance and scheduling and timing preferences), and routing strategy.

There are three main types of goods to consider: equipment, consumables and parcels. These goods are moved by different collaborative configurations of manufacturers, retailers and logistics service providers. The collaborative outcome determines the contours of a logistics concept. The final outlook of the logistics concept is determined by a set of choices that are related to three main

elements: distribution location, distribution network and distribution traffic. As part of the collaboration, some of these choices may already be fixed. Filling in the other choices is assumed to be the role of the logistics service provider. The freight system diagram includes the following choices:

- Choice of collaboration;
- Choice of distribution location;
- Mode choice for trip I transport;
- Choice of distribution network (i.e. combined choice of fleet and equipment ownership, volume and frequency, and scheduling and timing);
- Fleet and equipment ownership choice;
- Volume and frequency choice;
- Scheduling and timing choice;
- Choice of distribution traffic (i.e. routing).

Interactions between the system diagrams. Although we separated the system diagrams for passengers and freight, in reality, the passenger and freight transport systems are not completely independent of each other. The three main ways by which passenger and freight transport come together are:

- **Spatial lay-out of the urban metropolitan area.** The spatial lay-out of an urban metropolitan area concerns the pattern of land use in the area, the location of residences, work, manufacturers, wholesalers, distribution centres, etc. The choices of businesses and households regarding spatial planning, though quite different, affect each other.
- **Infrastructure capacity.** Passenger and freight transport often compete for capacity on the same transport infrastructure. In urban metropolitan areas, this competition is mainly for capacity of the road infrastructure.
- **E-shopping.** An example of interaction between the passenger and freight transport is e-shopping, which has the potential to reduce the number of shopping trips undertaken by households and individuals, resulting in a decrease of passenger transport. However, the goods that are purchased on-line still have to be transported to the home of the people who purchased the goods. Thus, there is the potential for freight transport substituting passenger transport.

Scenario development. In order to understand the potential impacts of the e-Economy on the future demand for passenger and freight transport in cities and regions, the external factors driving these impacts need to be identified and understood. Since forecasting these factors, called Forces Driving Structural Changes (FDSCs), and the impact thereof is complex, we have developed several scenarios, i.e. coherent pictures of plausible futures. The scenarios provide, in addition to improved

understanding of the impacts of the e-Economy on passenger and freight transport, input for the virtual case studies (WP5) and the modelling of the impacts of the e-Economy on transport (WP6) in POET.

The scenarios developed in POET present different ways in which FDSCs may drive changes in transport in urban areas in the EU-15 in the coming fifteen years. The scenarios focus on the year 2020, but for modelling purposes (WP6), information on the situation in 2010 is also included in the scenarios. In the design of the scenarios, we have followed a systematic approach consisting of the following three steps:

- **Step 1: Identification of the FDSCs.** FDSCs are forces outside the system that act on the system and can lead to structural changes in the system. In identifying the FDSCs we made use of the literature review, which also includes information on the FDSCs. The following categories of FDSCs are included: demographic, administrative, spatial, economic, technological, social, business and transport developments.
- **Step 2: Classification of the FDSCs.** The next step is the classification of the identified FDSCs according to their degree of uncertainty (predetermined or uncertain) and their relevance to the outcomes of interest (high or low impact). The classification of FDSCs is based on the results from the state-of-the-art review, the workshop, and a small expert panel.
- **Step 3: Design of the scenarios.** After classification, the uncertain FDSCs in the high impact category form the key dimensions of the scenarios. Uncertain FDSCs in the low impact category are ignored.

Following the three abovementioned steps led to the design of three scenarios, namely: (1) Stagnant City (SC); (2) Intelligent City (IC); and (3) Networked City (NC). The three scenarios describe possible futures of European cities in the year 2020. Although it is certain that none of these futures will come true, the scenarios are useful as they provide understanding of the way in which future development, especially developments in the e-Economy, may affect the functioning of the transport system. Such understanding is needed to design policies that anticipate on and perhaps even steer future developments in a variety of policy fields, including policies in the fields of information and communication technology, spatial planning, and transport.

In brief, the "Stagnant City" scenario describes a future that is rather similar to the current situation. In that scenario the current trends are extrapolated, including a slow uptake of ICT. This scenario shows how the future might look if society trudges along and no major changes occur; the modelling exercise in WP 6 will show what the transport outcomes of such a scenario are expected to be.

In the "Intelligent City", there is a high uptake of ICT with the primary aim of making processes within society more efficient. ICT is primarily used by companies to make their production, logistics and distribution processes more efficient. Citizens mainly use ICT to acquire information on the most efficient transport mode, time-of-day and route. The modelling exercise in WP 6 will improve our understanding of the transport outcomes of these developments. This information will help us

determine whether these outcomes are desirable, and in that case, what can be done to realise "intelligent cities".

Finally, in the "Networked City", the uptake of ICT is also high, but ICT is mainly used to substitute physical transport. The focus is thus on transport prevention and not on more efficient transport as in the "Intelligent City". Again, the modelling exercise in WP 6 will improve our understanding of the transport outcomes of such a future, should enable us to determine whether these outcomes are desirable, and if in that case, should help us to design policies to realise "networked cities".

It needs to be stressed that the different potential futures do not only have different effects on passenger and freight transport, but also lead to different types of societies, in terms of, for example, spatial planning, social interaction, etc. These effects also have to be taken into account when thinking about policies affecting the relationship between the e-Economy and transport. However, in POET the focus is on better understanding the impact of e-Economy developments on transport.

Workshop. The workshop to validate the system diagram for passenger and freight transport, and the choice profiles included in each was held on 31 October 2003 in Amsterdam. Experts in the field of transport, logistics and telecommunications were invited to participate in this workshop to discuss the outputs of the first phase of the POET-project, i.e. the conceptual models for passenger and freight transport that were developed. The workshop was attended by 15 external experts and 13 POET project team members.

During the workshop the conceptual models and the choice profiles were presented and discussed. The participants indicated that they believed that the presented approach is useful to gain more insight in the way in which developments in information and communication technology can affect the decisions that stakeholders make related to the movement of passengers and freight. In addition to detailed suggestions to improve the conceptual models and the choice profiles, the workshop also produced several important points of interest that need to be taken into account in the remainder of the POET-project. One of these points is that we should not ignore the interactions between the conceptual models for passengers and freight.

3.1.3 WP4 – Actual case studies of passenger and freight transport

The objectives of WP4 as stated in D1 – Inception report are:

- The development of relevant case studies, representing major decision-making behaviour of individuals and firms that are expected to have significant impact on freight and passenger transport;
- The analysis of the results of the actual case studies and revisions of conceptual models and system diagrams developed in WP3.

Eleven case studies were chosen within POET as a way to learn about how various actors respond to developments in the e-Economy and the (conflicting) effects of ICT on passenger and freight transport. Below you find an overview of the selected cases, a brief introduction of the case, and a summary of the main findings of the case.

Table 2 Description and findings of the actual case studies

Case study name	Brief description	Main findings
1. Woolworths	This case explores the impact of RFIDs (in combination with other ICT) on asset management and efficiency (reduce total trip time), planning and visibility and delivery accuracy. The main barriers for the introduction of RFIDs are costs and a lack of standards. The case is based on a pilot study, conducted in the UK.	▪ Impact on asset management and efficiency (reduce total trip time); Increased capacity usage, utilisation increasing from 10% to 40%. This is only achievable as part of an integrated ICT and planning system solution, NOT purely the result of RFID.
2. Danzas Chemicals	This case explores the impact of integrated planning and improved ICT on logistics and transport. ICT in combination with integrated planning (of truck and tank containers) is used to improve freight flow analyses.	▪ Improvement of load factor by reducing empty kilometres with 1 million kilometres per year for Danzas; ▪ Reduction of 3.7 million km (17% reduction) in vehicle km, due to modal shift and transport efficiency.
3. KIALA	This case is a good example of a 4th Party LSP who has outsourced all asset-based activities and whose core business is focused around the exchange of information, enabled by state-of-the-art ICT systems.	▪ For the Dutch home-shopping market the take-out store concept can lead to a reduction of 875,000 transport kilometres a year; ▪ Better vehicle utilisation, due to bundling; ▪ Trip type shift, from freight delivery to passenger pick-up (often in combination with other passenger related transport flows).
4. Satellite newspapers	The Satellite Newspapers case describes how newspapers are digitised and printed on demand all around the world, using file transfer via satellites. Physical transport of newspapers is replaced by information transmission. Furthermore new markets can be targeted. Transport	▪ Reduction of freight transport flows and elimination of return flows for a specific market segment in the media (newspaper) market.

	kilometres are reduced (in delivery and return flows) and inventory costs minimised due to the printing on demand.	
5. Digital Parts Transfer	Digital Parts Transfer (DPT) is a new logistical service concept. DPT transmits (CAD) product descriptions and (CAM) production specifications to production locations, which then are transformed into physical (spare) parts and products. The concept, which is still in pilot phase, can lead to a reduction of transport kilometres (because products will be transported on much shorter distances) and a reduction of inventory costs (given the production on-demand). However, the open marketplace concept might also lead to more transport, depending on the decision metrics of the final customer (being cost, delivery time and/or quality).	▪ The expected kilometres reduction for the Netherlands is estimated at 14,669,200 kilometres per year; ▪ The associated emission reduction of CO2 is estimated at 14,669,200 / 6 (litre diesel oil per kilometre truck) x 2,6 (kg CO2 / litre) = 6,356.65 ton CO2 per year; ▪ The associated emission reduction of NOX is 14,669,200 x 0.0016 = 23.47 ton NOX per year; ▪ For non time critical production, many manufacturers will probably select production on the basis of quality and cost, rather than production location. In these cases the DPT concept might also lead to more transport kilometres. Therefore the exact effects on transport are not yet clear.
6. Dutch Flower Auctions	The East African Flower (EAF) company set up a tele-flower Auction (TFA) in 1994, the first remote flower auction in the Netherlands. Usage of this e-auction led to a reduction in person transport kilometres (traders no longer need to physically be present in the auction hall). The case further discusses possible future directions for the impact of e-auctions on actual freight flows.	▪ Estimated reduction of 3,074,368 person kilometres per year for the TFA auction buyers (work related transport); ▪ Unclear / conflicting effects with regards to freight transport flows.
7. Interpolis	This case shows the impact of telecommuting based on a new vision of working. This vision consists of People & organisation, working environment & building and information management & ICT. Based on literature research and a simulation model effects are predicted on transport (substitution), number of trips and pollution	▪ Estimated reduction in passenger commuting kilometres of 12,682 km per year for Interpolis; ▪ Furthermore, the possibility of flexible arrival time at work leads to possibilities of travelling during non-peak hours, thus to flexibility in departure time choices, reduction of daily

	levels.	commuting travel time and a potential re-distribution of travel demand.
8. Puget Sound	This case describes the effects of Intelligent Transportation Systems in the Seattle region, which provide travellers information pre-trip and en-route. This assists them in better decisions with regards to trip planning, leading to a more efficient distribution of travellers' route and nodes.	▪ Advanced Traveller Information Systems offer the promise of better-informed travel decisions and more efficient use of transportation infrastructure. This information can help individuals readjust their travel decisions to account for rapidly changing travel conditions, make more informed travel decisions, reduce travel time and stress, and reduce congestion in transportation networks.
9. Trondheim road pricing	Road pricing is a flexible and efficient way to charge road users for their actual road use. It can be differentiated by vehicle type or time of the day. Traditionally road pricing has been used as a demand management, congestion reduction tool, although in an increasing number of cases, toll schemes are implemented to finance infrastructure investment.	▪ Small decrease in total car traffic crossing the toll ring in the inbound direction; ▪ Inbound car traffic decreased by 10 percent during the charged periods, and increased by 8-9 percent during uncharged periods at evenings and at weekends, causing the volume of traffic to fall by an average of 4 percent overall the impact on shopping journeys has been greater than for other types of trips; ▪ Slight increase in the use of public transport, cycling and motorcycle trips for work purposes; ▪ It is estimated that the improvements introduced will reduce the volume of carbon dioxide emissions by 6500 tons per year; ▪ Accidents have fallen by between 60 and 70 percent on the new sections of road, mainly because the mixed traffic pattern has been removed.
10. e-Government	Governments are increasingly implementing electronic services to increase service levels, work more efficient and effective and to offer a	▪ *Passenger travel:* Over the past four years the number of visitors, e.g. number of trips to IBG's regional centres, has decreased by

	better product to individuals and households (consumers), and businesses. The nature of many e-Government efforts is such that it improves service through reducing physical transport or other efforts from the side of the user. This case describes the potential impacts that e-Government might have on transport by looking at IBG, the organisation responsible for student grant and loans in the Netherlands.	7.5% per annum. If this trend proliferates, by 2020 a 75% reduction over 20 years will have taken place; ▪ *Freight transport:* Over the past three years the number of postal items has decreased by 12% per annum. If this trend proliferates, by 2020 an 80% reduction of postal items over 20 years may take place.
11. European Car Sharing	In car sharing programs individuals gain the benefits of private car use without the costs and responsibilities of ownership. Instead of owning one or more cars, a household or business accesses a fleet of shared-use vehicles on an as-needed basis. ICT is used for program management and customer service via improved vehicle access, reservations, and billing methods. Especially, ECS makes use of ICT-applications to manage their car park, keep track of car-kilometres, assign cars to members, and invoice car usage. The greater outcome of car sharing is the reduction in travel km by consumers and the increased capacity usage by sharing travel resources. Travellers who join car-sharing organisations and reduce their household fleet by one vehicle end up reducing their overall vehicle travel by one-third to one-half.	▪ While early studies provide indications of positive shared-use vehicle impacts, there is inconsistency among methodological approaches and findings, confounding aggregate-level analyses. To evaluate program-wide effects, more systematic data collection and analysis approaches are needed.

The eleven case studies illustrate different ways in which developments in the e-Economy may affect the future demand for passenger and freight transport. Despite the differences in nature, it is possible to draw some overall conclusions from the case studies. These conclusions are discussed in much more detail in D7 – Results from the actual case studies.

- The availability of evidence on the impact of specific ICT-applications on transport is scanty, and more research needs to be done to fully understand this relationship;
- ICT is primarily an enabler and not a driver of changes in the transport system;
- The uptake of ICT-applications is slower than could be expected, because of existing barriers. Taking away these barriers can facilitate the uptake of ICT-applications;
- The uptake of ICT-applications has led to reductions in passenger kilometre and/or tonne kilometres. However, the role of ICT in transport reduction should not be overestimated as the case studies could be best practices;
- E-Economy developments may lead to replacement of passenger transport by freight transport;
- The potential impact of ICT on transport volume could be substantial, if there would be a wide uptake of ICT-applications.

3.1.4 WP5 – Virtual case studies of passenger and freight transport

Objective. WP5 involves the choice and development of the virtual case studies. Virtual case studies are necessary because our knowledge about the impacts of the e-Economy on transport is inadequate for representing all of the key decision points for making various choices, the relevant trends, or the impacts of e-mode in 2010. The objective of the virtual case studies is to provide additional information, complementing the information and knowledge gathered from the literature review and the actual case studies, on the potential behaviour of businesses and individuals/households under different future scenarios, in order to identify the impacts of the e-Economy on the demand for passenger and freight transport.

The approach. Under this task virtual case studies are developed that represent future situations to the decision-making entities, in which new ICT becomes available. Decision makers are provided with realistic scenarios describing the future situation and are presented with a set of choice alternatives. Since it is impossible to represent the complete set of choices that individuals, households and businesses could face in the future, a few choices of key importance were selected to be studied in detail. For the passenger studies, a tool called Information Acceleration (IA) simulator was developed to collect survey data on-line. In these surveys, data on both Revealed Preferences and Stated Preferences are collected via the Internet from various countries. The IA simulators were

developed in English, and were translated into four other languages (Dutch, Italian, Hebrew and Greek).

For the passenger case studies, three Internet surveys were conducted focusing on the following issues:

1. Teleworking: This survey is aimed at gaining an insight in the future of teleworking and the degree to which this would affect choice of residential location and commuting patterns;
2. Business travel: This survey is aimed at gaining an insight in the future of business travel and the way in which this would affect travel patterns of employees;
3. E-shopping: This survey is aimed at gaining an insight in the expected uptake of e-shopping and the way in which this would affect transport behaviour.

The surveys on teleworking and e-shopping were sent to individuals who were asked to answer questions regarding their own future. The survey on business travel was sent to human resource managers of companies who were asked to answer questions regarding the future of teleworking in their organisation. The number of successfully completed interviews is presented in Table 3 below.

Table 3 Number of successfully completed interviews

	business	e-shopping	residential
Total	**182**	**321**	**1022**

The freight survey was conducted by interviewing logistic managers of medium to large companies over the telephone. The interviews were aimed at gaining an insight in the current logistic operations of companies, and the expected changes to these operations under different scenarios. The interviewees were presented with different sets of potential ICT-developments for the year 2010, and were asked to assess how these developments would affect freight transport and logistics. In total, 77 telephone interviews were completed.

The results of passenger case study 1: Business-related travel in an ICT-rich environment. The objective here was to explore how an ICT rich environment affects the amount of time spent by employees working from home and the volume of business-related travel. 182 individuals, from five countries, responded to the business questionnaire. Nearly 70% of the respondents indicated to be in a senior position in their group, leading us to believe that their responses reflect the group's policies and attitudes quite well. From the survey, it appears that the organisations tend to discourage their employees from working at home. Almost 60% of the sample would prefer their employees not to work at home, and 10% of the organisations actively discourage their employees from working at home. We estimated two sets of models, namely: (1) a model to predict the amount of working from home (or more precisely, such commuting as remains); and (2) a model to predict the number of business-related trips. The models suggest that the percentage of the workforce who will be working

from home on a given day in 2010 will be as follows (the percentage in 2004 was 5.3% for the Northern European countries studied):

- 10.0% if journey times and home office costs stay as they are in 2004;
- 12.5 if journey times increase by 20%;
- 11.9% if home working costs decrease significantly;
- 14.4% if journey times increase by 20% and home working costs decrease significantly.

The number of business trips in 2010 would:

- Reduce by 13.3% if the capability of ICT rises in line with the most bullish forecasts and if its costs decrease significantly;
- Reduce by 13.8% if journey times increase by 20%;
- Reduce by 20.2% if the capability of ICT rises in line with the industry's most optimistic (bullish) forecasts, its costs decrease significantly and journey times increase by 20%;
- Reduce by 6.9% if travel conditions and ICT costs and capabilities change as per pre-2004 trend.

The average business trip length would be 5.5% shorter if the most bullish ICT forecasts are fulfilled and if journey times increase by 20% than it would be if these things would stay as they were in 2004.

The results of passenger case study 2: Shopping-related travel in an ICT-rich environment. The objective of this case study was to explore whether the increasing opportunities for e-shopping would affect the number and type of trips and travel undertaken both for shopping and for other non systematic purposes (leisure, vacation, etc.). A total of 319 individuals responded to the questionnaire.

1. 40% of the respondents expect to make increasing use of e-shopping in at least one product category;
2. The highest observed increases in e-shopping usage are for purchasing electronic goods (26%) and computer software (21%), while the smallest increase is in the category of leisure products (15%);
3. 28% of the respondents expect to make less shopping trips in virtue of their greater use of e-shopping;
4. 96-97% of the respondents expect not to change the number of trips for other non-systematic purposes due to a decrease in their number of shopping trips (complementarity effect).

The main decrease in the shopping trip number is found in the "groceries" category (mean reduction of 0.105 daily shopping trips), while the smallest decreases are found in the categories of "computer

software" and "electronic goods". This is an expected result, as grocery trips are mainly characterised by a daily frequency while the latter are rare.

A model was used to estimate the average difference between now and 2010, in the number of shopping trips undertaken by individuals as a function of problems with credit card payment, speed and cost of internet connections, and socio-economic and demographic variables. The model estimation results show:

1. Some groups of people (young people, persons who usually work with internet, etc.) respond more to technological improvements and make more use of e-shopping opportunities;
2. The technological improvements, which are expected to have the greatest effects on the increase of e-shopping, and on the consequent decrease of shopping trips, are related to the delivery of goods ordered via the internet and to the security problems that are associated with on-line transactions.

The results of passenger case study 3: Impact of ICT on re-location and teleworking decisions.

The objective of this case study was to explore the potential impacts of the use of ICT on the choice of employees to change residential location and the effect this decision may have on their commuting patterns and travel behaviour. A total of 512 individuals completed the questionnaire. Surprisingly, the number of people who telework did not seem to differ much based on whether people live in the city, the suburbs, or somewhere else.

We developed five models to study re-location decisions and its impact on travel and commuting patterns, namely models to estimate: (1) choice to relocate; (2) the number of teleworking days; (3) weekly commuting distance; (4) frequency of trips for other purposes than those related to work; and (5) weekly distance travelled for non work related reasons. Only the first two models were used, as these were most reliable. The relocation model produced the following results:

- Individuals living in cities are more likely to move to an intelligent city then to a networked suburb with high ICTs and least to a stagnant city. Individuals living in suburbs are more likely to move to a suburb then to a city with high ICTs and least to a stagnant city. Individuals living in small towns and interurban areas are equally likely to move to a suburb, or to a city with high ICTs and least likely to move to a stagnant city;
- Individuals that currently telework, are less likely to relocate than non-teleworkers;
- The higher the car-ownership the less likely relocation becomes;
- Households with kids in the age group 6 to 12 years old are less likely to relocate.

In metropolitan areas, the teleworking days model produced the following result:

- Individuals living in the United Kingdom and the Netherlands are more likely to telework than individuals living in Greece, Italy and Israel.

- Employees living in households with young children (younger than six) are more likely to telework than those living in households without children, or older children.
- Individuals in their fourties are more willing to telework in 2010 than those who are younger or older.
- Women are more likely to telework than men.

The results of the freight case studies. Both from the literature review and the development of the freight system diagram, freight transport appears to be highly dependent on the organisation of the supply chain. In general three parties make up a supply chain: (1) manufacturers/producers; (2) logistic service providers (LSPs); and (3) retailers. As the objective of the virtual case studies was to identify developments in the e-Economy that could have a large impact on freight transport, actors in supply chains were selected to predict the transport impact. Specifically the following actors were selected to be interviewed for the virtual freight case studies:

- Retailers (groceries, other consumables);
- LSPs (e.g. parcel distributors);
- Other parties (manufacturers, wholesalers) involved in deliveries to retail.

The choices that are affected most by the developments in the e-Economy and logistics are:

- Changes in the load factor and the operational vehicle mix (with several developments affecting the load factors, both positively and negatively);
- Number of trips (substitution of shopping trips in passenger transport by home delivery).

Choices that are also affected, but probably to a much lesser extent, certainly at the urban level, are:

- Substitution of trips by the e-mode (e.g. mail, newspapers);
- Mode choice (e.g. more intermodal transport).

In order to assure participation of sufficient and appropriate supply chain actors, we chose to conduct face-to-face interviews and telephone interviews. These interviews offered the possibility of asking follow up questions and seeking clarifications, something that would not have been possible with an on-line survey. Eight face-to-face interviews were conducted in Germany and 77 telephone interviews were conducted in the following six countries: Greece, Israel, Italy, Netherlands, United Kingdom, and Sweden. Of the 77 companies included in the sample, 41% were active in logistics and freight distribution, 26% were retailers, and the remaining were manufacturers (20%) and wholesalers (13%). The analysis of results showed that:

1. The scope of the firms in almost 50% of the cases is national, as opposed to 10% local/regional and 40% international;
2. The median transport frequency for the deliveries to retail is five times per week;

3. The median outbound load factor is 80% and the mean is 74%;
4. On average, 27% of all kilometres is driven empty.

Specifically, we developed models to estimate the following:

1. Ratio of vehicle load in 2010 and 2004 for outbound transports;
2. Ratio of the percentage of return loads in 2010 and 2004;
3. Ratio of the load factor for the return load in 2010 and 2004;
4. Ratio of empty kilometres in the tours in 2010 and 2004;
5. Percent change in the number of deliveries to retailers between 2004 and 2010;
6. The growth index (2004=100) in the number of stops (other than for the delivery studied);
7. The share of cars and small vans (up to 3.5 tones) in all vehicles used for the transport to retail in 2010.

A significant influence of e-Economy developments was found for models 1, 2, 3, 5, 6 and 7. For the share of empty kilometres no significant influence of e-Economy variables was found. The survey outcomes of WP5 serve as an input for the development of the "front-end models" that are used in combination with existing urban transport models in WP6.

3.1.5 WP6 – Modelling the impacts of the e-Economy

Objectives. The objectives of WP6 were: (1) evaluation of the effects of developments in the e-Economy on the demand for transport in cities and regions; and (2) estimation of the impacts of meeting this demand for transport on the competitiveness of these cities and regions, emissions, energy use, and other relevant impacts.

The approach. In the modelling of the impacts of the e-Economy on transport in a number of selected urban areas in Europe, several pieces of information within POET come together. The modelling for the urban areas used existing transport models (passengers and freight) for Paris, Stockholm, Naples, Hamburg and The Randstad (The Netherlands). Secondly, it used scenarios for the year 2010, based on the scenario work earlier in POET. The scenarios used are[2]:

- Stagnant City (=reference 2010);
- Medium Adoption of the e-Economy, i.e. ICT develops very favourably, but we take a more conservative view on how people and firms react to it;
- High Adoption of the e-Economy, i.e. ICT develops very favourably (also increasing effective road capacity), and people and firms react very positively to it (in terms of teleworking,

[2] The Networked City from the earlier scenario work is defined now as High Adoption for passengers and Medium Adoption for freight. The Intelligent City is now defined as Medium Adoption for passengers and High Adoption for freight and e-City is defined as High Adoption for both.

telebusiness, teleshopping, relocation of the population and changes in the load factor and vehicle mix in freight);

- High Adoption Plus. This is the same as High Adoption, but with additional e-learning and car-sharing.

For both the Medium and the High Adoption scenario, a model with and a model without relocation of the population was estimated.

The third element in the modelling at the urban level is the use of so-called front-end models, estimated on the data from the virtual case studies of WP5 in POET. Because the existing transport models lack levers to include many of the e-Economy effects on transport, these effects are handled in new models for tour/trip frequency by purpose, relocation of persons and efficiency in freight transport (the front-end models). These models were expanded to each of our urban study areas to take the specific socio-demographic structure of the population and employment in each study area into account. After that, the different scenarios were inserted into the front-end models and the outcomes of the front-end models were used as inputs for the transport models. The transport models produce mode and destination choice and assignment to the networks, with feedback effects of congestion on these choices. The outcomes in terms of vehicle kilometres were also used to calculate impacts of the e-Economy on energy use, emissions and traffic accidents. Also for some areas, we calculated impacts on congestion and accessibility.

The results. The results for passenger transport are based on five urban areas; those for freight transport on Hamburg and Naples. For the five urban areas we investigated with this combination of scenarios, transport models, front-end models and exogenous rates, we found for the High Adoption scenario substantial reductions in passenger kilometres in Naples (-9%), the Randstad (-8%), Paris (-7%), Stockholm (-3%) and Hamburg (-3%). Considerably larger reductions in passenger transport were obtained for situations where ICT would lead to relocation of the population from rural to suburban and to urban areas with good ICT connections and from urban to suburban areas. Also the outcomes for passenger transport depend crucially on whether the number of tours for a travel purpose that is very important in an area is reduced considerably (as in the simulations for Paris for shopping).

In the Medium Adoption scenario, the reductions in the Randstad (-7%), Paris (-6%), Naples (-6%), Stockholm (-3%) and Hamburg (-1%) are the same or smaller, because the behavioural reaction of the travellers to the e-Economy is more modest. Given the nature of the data used to estimate these behavioural reactions (small samples, low response rates, probably with an overrepresentation of those interested in ICT and early adopters), this scenario seems more likely. The scenario might even lead to an increase in passenger kilometrage (e.g. because road capacity is increased), but we think that a modest reduction in passenger kilometrage is most likely. In most cases the share of the car in total passenger kilometrage goes down somewhat.

The High Adoption Plus scenario has almost the same outcomes as the High Adoption scenario. The addition of e-learning and car-sharing did only contribute marginally to further reducing mobility. Teleworking, e-business and teleshopping appear to have a bigger impact on travel demand.

For freight transport, we find that both in the High Adoption scenario and the Medium Adoption scenario, the number of lorry kilometres increases. This is the net result of two forces working in opposite directions:

- Developments in the e-Economy that increase the efficiency of freight transport: more optimal planning of delivery tours, information and e-markets for return loads.
- Developments in the e-Economy (smaller inventories, just-in-time management, smaller and more frequent deliveries, effective and fast consumer response systems) that decrease the efficiency of freight transport.

In both areas studied (as well as in the literature and the interviews with industry experts) we see clear indications that the latter effect will be stronger than the former: the number of road vehicle kilometres will increase by a few percent because of the e-Economy developments.

In the Hamburg application, the impacts on passenger transport exceed those in freight transport. The net effect for most combinations of passenger and freight scenarios therefore is a (small) decrease in total passenger and freight vehicle kilometres. For Naples the net effect without relocation of the population is also a decrease in total passenger and freight vehicle kilometres. Given that the impacts for passengers in Stockholm, Paris and the Randstad considerably exceed the impacts on passenger kilometrage in Naples and Hamburg, we expect that for those areas the reductions in passenger car kilometres would clearly outweigh the increases in lorry kilometrage.

The expected reductions in vehicle kilometres lead to less energy use and emissions of greenhouse gases and local pollutants compared to the reference for 2010. Congestion decreases because of the e-Economy (Stockholm, Randstad) and in Stockholm accessibility increases in spite of the decrease in the number of tours made. On the other hand, the relocation with increased teleworking, as predicted for the e-Economy scenarios for Stockholm, might also lead to less lively city centres.

Recommendations for policymaking and further research. The net effect of the e-Economy on passenger and freight transport taken together in an urban area is likely to be a reduction in the number of vehicle kilometres. This is not an aim in itself. What matters for society is whether this will increase welfare. This is quite likely to happen. The reduction in passenger travel is for a large part reached by substituting electronic communication for physical communication, so for the relevant travel purposes, there is not really a reduction in activities that used to take place at other destinations than the home, but only in travel. Most of the gains from these activities will be retained (in principle there might even be an increase in the utility from those activities, now that they are carried out at home). For trips that are not substituted, the travel time decreases, as congestion is reduced. Furthermore, the external effects (energy use, emissions, accidents) from travel are reduced.

And the reduction in congestion and increase in accessibility might make the region more competitive (e.g. with respect to location choice of firms).

Given the expected positive welfare gains from e-Economy changes on and through transport, policies to promote these e-Economy developments (e.g. standardisation, awareness campaigns, fiscal incentives, subsidies) would be beneficial. These policies should focus on the adoption of the e-Economy by private households, since that is the sector where reductions in kilometrage can be expected. Such policies could turn out to be more effective than more traditional transport policies (such as investments in specific public transport infrastructure projects). Slowing down the adoption of ICT by firms, as a means to avoid the likely increases in freight vehicle kilometres, is probably not a good course of action. This might harm the competitive position of European firms. If e-Economy developments should lead to more vehicle kilometres in freight transport and more emissions, these effects should be countered by transport and environmental policy measures, not by promoting a slower adoption of ICT by firms (if that were possible).

If the e-Economy would increase freight and reduces passenger traffic, then this would also have consequences for infrastructure planning, since passenger and freight transport have different Origin-Destination patterns, concentrate in different time periods, etc.

In this project, new models for residential choice and travel frequency in passenger transport and for vehicle loads and vehicle mix in freight transport were combined with existing transport models. One of the observations was that the final outcomes depend crucially on the impact of the e-Economy on relocation. Given this outcome, we recommend to further investigate the impacts of the e-Economy on land use, both in greater depth (a full-scale residential choice model based on a larger database) and in a broader sense (in POET we only shifted population, not employment). This can all be integrated in land use – transport models, a number of which already exist (e.g. in Sweden, the UK and the Netherlands).

3.2 Comparison of achieved objectives with stated objectives

Although the initial stage of the project generally went according to plan, we ran into difficulties in the second half of the second reporting period, i.e. circa 18 months into the project. The difficulties were caused by our ambitious objective to conduct three virtual case studies on the impact of the e-Economy on passenger transport. To better understand this, we have conducted three internet-based surveys in each of the following five countries: Greece, Israel, Italy, the Netherlands; and the United Kingdom. Data collection from these virtual case studies should have been completed by September 2004. Unfortunately, this was not the case. There were several reasons for the delay:

- First, the actual preparation of the virtual case studies has proven to be more time consuming and difficult than we had expected. The analytical difficulties aside, the translation of the

case studies into Dutch, Greek, Italian and Hebrew was more time consuming than expected;

- Second, there have been some technical difficulties (slow access times) in completing these on-line surveys. Resolving these technical difficulties has also taken much longer than planned;
- Finally, the response rate has been low, and some of the responses that we have gotten were incomplete and could not be used. We had to extend the period of data collection in order to collect sufficient data to conduct a sound analysis.

This delay in data collection also caused a delay in the modelling in WP6. Although we were able to do some of the work needed to complete WP6 before the surveys were completed, a significant amount of the work had to be done once the virtual case studies were completed. As a consequence, we needed to request an extension of the POET-contract in order to do full justice to the project and deliver high quality results. The requested contract extension was granted to us by the European Commission.

3.3 Coordination with other networks

Many of the partners that participate in the POET Consortium are involved in several other projects that have relevance for the POET project as well. RAND Europe and Kessel + Partner are, for example, both involved in the SUMMA-project on Sustainable Development (see: www.summa-eu.org) and in a project called "Integrierte Gesamtverkehrsplanung Nordrhein-Westfalen" which aims developed the future infrastructure investment plan for Northrhine-Westphalia and generated recommendations for the future transport policy (see: www.igvp.nrw.de). In addition, the POET Consortium made use of the results of the EXPEDITE project, coordinated by RAND Europe and funded by DGTREN, which aimed at generating forecasts for passenger and freight transport for Europe for 2005, 2010, 2015 and 2020, showing which policies can be effective to reach modal shifts, and identifying market segments that are sensitive to policy measures. Finally, the POET Consortium is in close contact with the STELLA-project, a project focusing on Sustainable Transport in Europe and Links and Liaisons with America. This project includes a dedicated focus group focusing on ICT, innovation and the transport system (see: www.stellaproject.org).

As the POET-project focuses on the effect of developments in the e-Economy on transport, we have not only cooperated with other projects funded by DGTREN, but we have also paid close attention to (at least) three EC projects funded by DG-IST in which RAND Europe has been involved, namely:

- TERRA 2000: The primary objective of TERRA 2000 was to produce a library of scenarios combining informed and consistent assumptions about the New Economy; a coherent set of

key issues relevant to European policy; assumptions about key actors; closely integrated state-of-the-art projections; and an assessment of the implications.

- SEAMATE: The primary objective of SEAMATE was to estimate the macroeconomic impact of changes brought about by the new economy. As part of this, SEAMATE examined developments in the new economy and the impact of these changes on the transport system.
- PRISMA: The PRISMA research project aimed at providing a systematic analysis and synthesis of current and future impacts of new information and communication technology on government services (including transport services) in Europe.

4. List of deliverables

Table 7: List of deliverables and issuing dates

Deliverable	Nature of deliverable and brief description	Actual issue date	Planned issue date[3]	Status at the EC
D1	Inception report	21 March 2003	21 March 2003	Accepted
D2	State of the art review	6 June 2003	1 June 2003	Accepted
D3	System diagrams and choice profiles	1 December 2003	1 December 2003	Accepted
D4	Scenarios	16 April 2004	31 March 2004	Accepted
D5	Input for e-Europe initiative	4 August 2004	1 July 2004	In review
D6	Selection of cases and plans for carrying out actual case studies	29 July 2003	1 August 2003	Accepted
D7	Results from actual case studies	28 April 2004	1 May 2004	Accepted
D8	Selection of cases and plans for carrying out virtual case studies	Original Version: 30 January 2004 Revised version: 12 March 2004	1 February 2004	Accepted
D9	Results from virtual case studies	11 May 2005	10 May 2005	In review
D10	Results of six case studies on urban transport	11 May 2005	10 May 2005	In review
D11	Plans for creating and maintaining the project website	1 May 2003	1 May 2003	Accepted
D12	Plans for creating and distributing project newsletter	18 June 2003	1 June 2003	Accepted
D13	A brochure describing main results of the study	N/a	10 May 2005	N/a

[3] The revised planning, incorporating the two-months contract extension, is presented in Section 7.3.

5. Comparison of initially planned activities and work actually accomplished

With a two months extension of the project, we were able to complete the project as initially planned. The table below illustrates the planning of the deliverables in POET and the actual date of submission of each of the deliverables.

Table 4 Overview of the POET-project

Deliverables	Planned delivery	Actual delivery
D1 – Inception report	March 2003	March 2003
D11 – Plans for creating and maintaining the project website	May 2003	May 2003
D2 – State of the art review	June 2003	June 2003
D12 – Plans for creating and distributing project newsletter	June 2003	June 2003
D6 – Selection of cases and plans for carrying out actual case studies	August 2003	July 2003
D3 – System diagrams and choice profiles	December 2003	January 2004
D4 – Scenarios	December 2003	April 2004
D8 – Selection of cases and plans for carrying out virtual case studies	February 2004	March 2004
D7 – Results from actual case studies	May 2004	April 2004
D5 – Input for e-Europe initiative	July 2004	August 2004
D9 – Results from virtual case studies	July 2004	May 2005
D10 – Results of six case studies on urban transport	January 2005	March 2005
D13 – A brochure describing main results of the study	April 2005	July 2005

The delay that can be seen in the table in submitting D4 – Scenarios, was brought about by a shift in content between D3 and D4. In the inception report, for which the dates in the planned delivery date column were derived, we had indicated that we would provide a D3 on the system diagrams and the scenarios and a D4 on the choice profiles. During the course of the project, it turned out to be more logical to combine the work on the system diagram with the work on the choice profiles. Therefore the results of these tasks are presented in one deliverable (D3). The work on the scenarios is presented in another deliverable (D4). However, due to this restructuring, some delay was incurred. This change was proposed to and accepted by the European Commission. Another, more significant delay, was incurred in gathering data for D9 – results of the virtual case studies, which was used to provide inputs to the modelling in D10. Due to a lower than expected response rate, the data collection period was extended, which caused a delay in the work on D10. Due to restructuring of the work on D10 and moving forward some of the work on this deliverable that did not require D9 input, seven out of the nine months delay of D9 were made up in D10.

6. Results and conclusions

In the first half of the project we established a wide variety of ways in which the e-Economy can impact passenger and freight transport, we identified which choices businesses, households and individuals make regarding transport and how these choices are made, and we gained a better understanding of the interaction between e-Economy developments, choice behaviour and the functioning of transport systems. In the second half of the project, we built upon the knowledge acquired to come to a more detailed understanding of the impact of developments in the e-Economy on passenger and freight transport. Very broadly speaking, the focus in the second half of the project was on:

- Better understanding of the context in which the relevant stakeholders (businesses, households and individuals) make decisions, by sketching different future scenarios;
- Where possible, quantification of the choices made by these stakeholders, by studying actual case studies that give an insight in the current uptake of specific ICT-applications and the transport consequences thereof, and by developing Stated Preference surveys that give an insight in the choice behaviour of the relevant stakeholders in different futures;
- Modelling the impact of e-Economy developments on passenger transport and freight distribution and related outcomes of interest (e.g. energy use and emissions) in cities/regions under different scenarios for the year 2010.

In this chapter we summarise the overall conclusions of the POET-project (Section 8.1), and we formulate policy recommendations based upon all work done in the POET-project (Section 8.2).

6.1 Key conclusions regarding the impact of the e-Economy on transport

Overall, POET predicts that developments in the e-Economy will lead to a decrease in passenger kilometres and an increase in freight vehicle kilometres. POET has estimated the impact of different types of developments in the e-Economy on transport. Some developments are expected to result in an increase in transport kilometres, whereas others are expected to have the opposite effect. Overall, POET predicts that developments in the e-Economy will lead to a decrease in passenger kilometres and an increase in freight vehicle kilometres. In order to formulate targeted policies to encourage or discourage uptake of specific ICT-applications, it is however important to gain an in-depth understanding of how specific transport outcomes are affected by specific developments in the e-Economy.

The expected reduction in passenger kilometres between 2004 and 2010 is mainly a consequence of increases in teleworking and teleshopping. The POET-project led to the following insights in the impact of e-Economy developments on passenger transport:

- Teleworking: Although the relative impact of e-Economy developments on teleworking is modest, in absolute terms the forecast increases in teleworking have the largest effect on the number of passenger kilometres, as commuting trips form a relatively large share of all passenger trips.
- E-shopping: The impact of the predicted increase in uptake of e-shopping leads to a relatively large decrease in shopping trips. We expect that this may also lead to an increase in freight transport, but this effect has not been modelled in POET. Although the impact on passenger kilometres is relatively large, the impact on congestion will be small because physical shopping trips are usually not made during the peak hours.
- Business travel: The predicted impact of e-Economy developments on business travel and passenger transport is small.
- E-learning and ICT-enabled car sharing: Although POET has not collected stated revealed and stated preference data on the impact of e-learning and ICT-enabled car sharing, we made assumptions about these developments in the High Adoption Plus scenario. The impact of these developments was marginal.

Based on the model outcomes, we can thus conclude that teleworking and e-shopping offer most potential to reduce passenger kilometres. In addition, the literature review and the actual case studies provide some evidence that intelligent transport systems may lead to a decrease in passenger kilometres.

The expected increase in freight kilometres between 2004 and 2010 is a consequence of several e-Economy developments that decrease the transport efficiency, in terms of load factors and vehicle trips, of freight transport. Although POET overall forecasts a slight increase in freight kilometres, the story with regard to freight transport is more diverse, and different developments are pointing in different directions:

- e-Economy developments such as more optimal planning of delivery tours, information and e-markets for return loads, will increase the efficiency of freight transport, e.g. these developments enable increased reliability of timing of shipments and a better utilisation of vehicles;
- e-Economy developments such as smaller inventories, just-in-time management, smaller and more frequent deliveries, effective and fast consumer response systems will decrease the efficiency of freight transport, e.g. due to economic optimisations in supply chains that are enabled by these developments, more trips cater to the same volume of freight, resulting in less tonnes per trip.

Overall, the impact of the latter developments outweigh the developments of the former, which results in a net increase in number of trips and less tonnes per trip, or a decrease in transport efficiency so to say.

6.2 Policy recommendations

Developments in the e-Economy touch on many aspects of our daily lives and permeate all sectors of the economy. A wide variety of choices affect the choices people make about their travel and transport. Thus, if policy is to have any hope of influencing or guiding any of the developments that are currently taking place, it has to be broad and consider the links between the choices of people affecting travel and transport decisions, and the links between different policy domains. Therefore, this Chapter focuses on the implications of the POET-results in the domains of information society, transport and other related policy domains (e.g. spatial planning, employment, environment). We will also discuss priorities for further research that may support DG TREN in setting its future research agenda. However, before going into specific policy recommendations in those domains, we would like to stress that it is very important to first determine the key objectives related to the e-Economy and transport.

As indicated above, the net effect of the e-Economy on transport is likely to be a reduction in the number of vehicle kilometres. However, this may not be an aim in itself. What matters for society is whether this will increase welfare. This is quite likely to happen. The reduction in passenger travel is for a large part reached by substituting electronic communication for physical communication, so for the relevant travel purposes, there is not really a reduction in activities that used to take place at other destinations than the home, but only in travel. Most of the gains from these activities will be retained. For trips that are not substituted, the travel time decreases, as congestion is reduced. Furthermore, the external effects (energy use, emissions, accidents) from travel are reduced. Finally, the reduction in congestion and increase in accessibility might make the region more competitive (e.g. with respect to location choice of firms).

As the above implies, there are different types of outcomes (congestion, emissions, energy use, safety, prosperity, etc.) that all relate to the welfare of society. However, different types of policies may affect these outcomes in different ways. For example, encouraging e-shopping may contribute to a reduction of passenger kilometres, an increase in freight kilometres, a small reduction in congestion, and an increase in emissions. Making fast consumer response systems in logistics less attractive, might counter the trend towards more frequent deliveries somewhat, but works again the competitive position of European firms. Therefore it is important for the European Commission to specify what the policy objectives are.

6.2.1 Information society

Based on results of our work, we have identified policy recommendations in the domain of the information society. These policy recommendations are either aimed at encouraging the positive effects of e-Economy developments on transport or at mitigating the negative effects of these developments.

The uptake of ICT-applications by households is expected to lead to reductions in passenger kilometres and therefore policy to encourage uptake of ICT by households is recommended. POET shows that increasing uptake of ICT by households (particularly teleworking and e-commerce and to a lesser extent e-learning, e-government, etc.) will contribute to a reduction of passenger kilometres. Although the impact is modest, these developments should be encouraged as small decreases in passenger kilometres (and possibly a better distribution of passenger transport over the day) may be well worth it. It is outside the scope of the POET-project to define which policies should be formulated to enhance uptake of ICT. Generally, the following types of policy approaches should be contemplated:

- **(Dis)Incentives** to make the uptake of ICT-applications more attractive, or physical transport less attractive. For example, teleworking can be encouraged through changing the regulation on reimbursements for commuting.
- **Taking away the barriers** that prevent people from replacing physical transport by electronic transactions. For example, improving the security of Internet transactions may encourage individuals to buy goods and services online.
- **Awareness raising campaigns** may make people aware of options to optimise their transport patterns. For example, information on the existence of intelligent transport systems or the location of telecentres may encourage people to travel less or to improve their mode, route and time-of-day choices.

These policies should focus on the adoption of the e-Economy by private households, since that is the sector where reductions in kilometrage can be expected, and could turn out to be more effective than more traditional transport policies (such as investments in specific public transport infrastructure projects).

Regarding freight transport, ICT-policies should focus on those e-Economy developments that decrease freight kilometres. In addition, transport and/or environmental policy should be formulated to deal with the adverse effects of the e-Economy on freight transport.

Slowing down the adoption of ICT by firms, as a means to avoid the likely increases in freight vehicle kilometres, is probably not a good course of action. This might harm the competitive position of European firms. If e-Economy developments should lead to more vehicle kilometres in freight

transport and more emissions, these effects should be countered by transport (e.g. fuel taxes) and environmental policy measures (e.g. emission tax), not by promoting a slower adoption of ICT by firms (if that were possible).

Expand the focus of the eEurope action plan to more than just technology, and include a consideration of organisational, institutional, financial, and social factors that play a role in the acceptance of new technologies. If the new technologies and ICT are going to help realise policy goals, the technologies have to be accepted and used by society. The organisational, social, and psychological factors influencing the adoption of a new technology are just as important as the price-capability combination offered by a new technology. For example, ICT is often portrayed as offering a large potential for reducing the demand for passenger transport (the so-called decoupling of economic growth and the growth of transport). The potential clearly exists. Yet in reality, the potential is, more often than not, not being realised (and neither the technology nor the price are the barriers to more widespread teleworking). One of the hypotheses in the POET project is that this potential is not being realised because of important factors that are not being taken into consideration, such as lifestyle preferences and attitudes. These factors may, for example, cause households and individuals to move further away from work, enabled by teleworking opportunities offered. As a consequence, the length of trips to work may increase and the number of trips may decrease.

Another potential role of government in this area could be to be the launching customer for new businesses and ideas/using based on ICT applications and aimed at improving the efficiency and/or performance of the transport system. For example, one of the eEurope 2005 objectives is to raise the level of trust in on-line transactions. Governments can help raise trust by conducting more and more business on-line, helping people to engage in these on-line transactions and giving people a chance to overcome any psychological resistance they may have.

6.2.2 Transport and transport infrastructure

Make better use of the opportunities ICT offers to collect data to monitor trends in transport. One of the problems in making transport policy in general is the lack of sufficiently detailed and high-quality data to help in the selection of alternatives and to assess the performance of policy measures. Several new information and communication technologies can potentially help in the collection of data and information. In the case of freight transport technologies such as Radio Frequency Identification (RFID) tags make it possible to monitor the movement of freight in considerable detail. However, companies have no reporting requirements and there is no institution/organisation with the responsibility for collecting and safeguarding this data. Similarly, devices installed in trucks can monitor the distances driven and the amount of time spent by drivers in their trucks. Furthermore, for

passengers new technologies (often in combination with existing technologies) can provide data and information that we currently do not collect because it is too expensive and or difficult to collect. For example, several European countries conduct passenger travel surveys. These surveys are time-consuming, expensive and often do not provide the level of detail that is needed to do research on, for example, how changes in life style can affect the demand for transport. Using some combination of electronic diaries and GPS (Galileo) detailed information can be collected on what individuals do 24 hours a day in terms of their travel choices.

In order to develop a long-term vision on planning of new infrastructure and infrastructure renewal, monitoring of e-Economy developments and their impact on transport is important. If the e-Economy would increase freight and reduces passenger traffic, then this would also have consequences for infrastructure planning, since passenger and freight transport have different Origin-Destination patterns, concentrate in different time periods, etc. As the realisation of new infrastructure should be planned well in advance, monitoring of trends in the e-Economy and their impact on transport is important to take timely action.

Intelligent transport systems have the potential to reduce congestion. Intelligent transport systems span a broad range of applications to enhance the automation and efficiency of transport infrastructure and logistics, and appear most significant in:

- Reducing uncertainty in decision-making of both households and businesses;
- Increasing reliability of services;
- Providing seamless implementation of user-pay principles; and
- Possibly also providing greater safety and security in the movement of people and freight (Stella).

The actual case studies illustrate the potential of this ICT-application. However, it is also acknowledged that there are obstacles, such as funding difficulties and problems with technical standards, that hinder the application of ITS services. POET shows that ITS has potential to change the demand for transport, and particularly the time-of-day choice and the mode choice. ITS can contribute to a reduction in congestion, but does not necessarily lead to a reduction in vehicle kilometres, emissions, etc. Policies to take away barriers the obstacles to ITS should therefore be considered.

Business decisions on location, logistics and related operations have to potential to significantly affect transport kilometres. The EC seeks to explore approaches to reap the benefits of ICT to achieve efficient and sustainable transport and mitigate any negative impacts ICT implementation in companies and supply chains might have on transport and environment. Since ICT offers opportunities for cost reduction to entrepreneurs, it will be a matter of time before these opportunities

will be seized and ICT applications implemented. It can safely be assumed, and is backed by the findings of POET, that an unbridled implementation of ICT in companies and supply chains will result in more freight transport. Goods will be traded with more distant locations and moved over larger distances, delivery sizes will drop resulting in more frequent deliveries, and the generalised cost of transport will drop which further induces transport. As we learned in WP3, the location choice of businesses and their distribution centres consists of a complex set of decisions that are directly related to the business and the distribution strategy chosen. Multiple actors are involved in such decisions and multiple factors play a role. At this moment, we are only beginning to understand how these decisions are being made. More research on this topic is needed (see below).

6.2.3 Priorities for further research

Priority research areas in better understanding the ICT-impact on transport. The objective of the POET-project was to provide a comprehensive overview of the impact of a wide range of e-Economy developments on transport in urban areas. Although we have been able to provide a better understanding of many of these developments, further research in this domain is also required. Priorities for further research include:

- **Role of e-commerce.** The growth of e-commerce, i.e. the production, distribution, marketing, sale or delivery of goods and services by electronic means, will change the distribution of goods, particularly consumer goods. However, it will also influence the diffusion of ICT-applications in logistics (e-logistics) and transport (e-fleet management). As some factors will result in reduced travel and others in increased travel, e-commerce may not contribute much to reduction of the total number of vehicle kilometres and the related energy use, emissions, etc. The increasing share of freight kilometres may even have a negative effect on emissions. In short, e-commerce may have a wide range of effects in different directions, and therefore a better understanding of the uptake of e-commerce and the related effects seems to be a priority area for further research.
    - To what extent and in what way does e-commerce impact on patterns and processes of people and freight movement logistics within urban regions?
- **Role of location decisions.** Currently, little is known about the relation between land use and transport. The POET-results have demonstrated that the impact of relocation on transport is potentially very large. However, we have not been able to gain a detailed understanding of residential location choices of households, and we were therefore not able to produce detailed estimates of the impact on transport. Several research questions need to be answered to better understand this relationship, including:

- How does telecommuting impact on the spatial link between residential choice and work behaviour? How are trip patterns and choice of transportation mode influenced by uses of ICT?
- What are the implications of wireless technologies for social and commercial behaviour and how will they impact on the timing and spacing of land uses and activity systems in urban areas?
- What is the link between ICT use at individual, household, and firm levels and the changing land use patterns and trip distances within metropolitan areas?

Priority areas regarding modelling of the transport consequences of the e-Economy. In POET we made use of existing transport models to estimate the impact of the e-Economy on transport. Although these models provide a sound estimate of transport outcomes, a better understanding of what is going on inside the system may be gained by making use of recent advances in transport modelling. Below we briefly discuss how the understanding of the e-Economy impact on transport may benefit from other modelling approaches:

- **Activity-based micro-simulation or agent-based models.** As the opportunities presented by the e-Economy may lead to activity (re)scheduling responses by individuals and households, it would be important to focus research efforts on developing micro-simulation models that model the activity scheduling process of each individual directly. Such models permit realistic inclusion of decision rules and provide a platform to ex-ante testing of policy measures (based on: Stella). Implementation of such models would provide a better opportunity to model the choices described in WP3 of POET. However, as these models simulate the behaviour of all individuals encompassed by the model, the computer capacity required to run the models is large and model runs are time-consuming.
- **Freight models.** For only two of the six urban areas studied in POET, freight models were available. These types of models were used to forecast internal trips, i.e. trips within the urban area studied. However, we also acknowledge that transport taking place within the urban area is influenced by worldwide transport flows, i.e. trip-I transport as defined in WP3. The models would benefit from inclusion of forecasts on long-distance freight movements for all modes, and particularly trucks.
- **Integration of freight and passenger models.** It is generally acknowledged that the current quality of freight models is lower than that of passenger models, and that advances in freight models are required. Based on the POET-results, we would not only plead for improvements in freight modelling, but would also like to encourage that (in the long-term), better models integrating freight and passenger transport are to be developed. The need for such models arises from the interaction between freight and passengers:
  - E.g. competition for infrastructure capacity

  - E.g. e-commerce may lead to less passengers and more freight

- **Integrating land use and transport models.** In this project, new models for residential choice and travel frequency in passenger transport and for vehicle loads and vehicle mix in freight transport were combined with existing transport models. One of the observations was that the final outcomes depend crucially on the impact of the e-Economy on relocation. Given this outcome, we recommend to further investigate the impacts of the e-Economy on land-use, both in greater depth (a full-scale residential choice model based on a larger database) and in a broader sense (in POET we only shifted population, not employment). This can all be integrated in land use – transport models, a number of which already exist (e.g. in Sweden, The UK and The Netherlands).

7. Acknowledgements

POET is a project of DG TREN and is part of the 5th Framework Programme. Whenever third party material was used in POET, the authorizations required from the information source have been secured.

The POET team wishes to thank Keith Keen, from EC DGTREN, who has been the project officer responsible for the POET-project for his guidance and responsiveness. In addition we would like to thank our colleagues of the SUMMA project, as we were able to benefit form the insights gained through that study.

Throughout the POET project, the POET team was supported by the reviewers, Andy Gillespie (University of Newcastle), Jeremy Millard (Danish Technology Institute), and Pat Mokhtarian (University of California), validating the outcomes of POET. In addition, on several occasions the POET team relied on groups of experts to provide feedback on the POET work.

An important part of POET consisted of data gathering, which would not have been possible without the participation of a large number of people filling out surveys and giving interviews.

Finally we would like to express our thanks to RAND Europe's financial and administrative support staff for enabling managing a project with the number of partners we had.

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