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Beyond transport policy — exploring and managing the external drivers of transport demand

Illustrative case studies from Europe

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Executive summary

The transport sector in Europe continues to increase its emissions of greenhouse gases, which remain a key challenge in creating a low-carbon future. The main cause of increased emissions is the growth in transport demand; freight and passenger traffic continue to grow at a very fast pace, outstripping gains made through fuel and energy efficiency. The vast majority of actions to reduce the carbon footprint of the transport sector has been taken within the transport sector itself and ignore the key drivers which create the demand for transport. A better understanding of the reasons behind the growth in transport demand is therefore crucial to formulating effective measures to manage and reduce the emissions.

Historically, the demand for transport has been examined by placing the transport sector at the centre of the analysis, and seeking variables that explain the observed changes to transport patterns. However, transport demand and growth are normally created by decisions and developments outside the transport sector; transport is more often a means to an end, such as shopping, working and holiday trips. Decisions made in these sectors outside of transport influence the carbon footprint of the transport sector as they are often taken without considering the consequences on transport demand and greenhouse gas emissions. To tackle the challenge of increasing CO_2 from transport, a detailed analysis of sectors of economic activities outside the transport sector is therefore needed.

In order to better understand these external drivers, this study formulated a conceptual framework to identify main sectors and factors which impact on demand. It shall be seen as an initial attempt to understand key sectors and factors which impact transport demand, and to identify measures that can be taken to manage demand. It is meant to facilitate the inclusion of demand management into the policy discussions on the development towards a sustainable transport system. It should also be noted that EEA yearly publish a TERM-report (Transport and Environment Reporting Mechanism) in which also the issue of transport demand is addressed (http://reports.eea.europa.eu/eea_report_2008_1/en/).

Following a literature review of approximately 90 publications, the factors that were identified included socio-demographic changes, economic growth and globalisation, physical changes to urban form/land use, organisational changes at workplaces and schools, socio-cultural changes and technological developments. The key sectors consisted of retail, leisure/tourism, business, education, and industry. Both passenger and freight transport demand were examined, though it is understood that those fields of transport have different drivers of transport demand.

The study used a case-study based approach, in order to focus efforts on a few issues of particular importance, and to demonstrate the effectiveness of the framework.

From a matrix of factors and sectors previously described, nine topics were identified as case study candidates, ranging from the effects of e-commerce on shopping journeys, to the demands of an ageing population on leisure trips.

A number of aspects such as carbon reduction potential, EU policy influence, cost effectiveness and political/social acceptability were considered to select the three following case studies:

- Effects of food production and consumption on shopping journeys and freight traffic;
- The increasing use of short-haul air travel for business and leisure travel;
- Effects of 'education based' travel on transport demand.

One obvious topic linked to transport demand is the role of physical planning and land use. This was however not addressed in depth in specific study due to the extensive coverage of this topic in the existing literature and due to the limited size of this project. (It can be mentioned that EEA have addressed one of those issues on land use and transport demand in a report on Urban Sprawl in Europe – http://reports.eea.europa.eu/eea_report_2006_10/en).

Each case study examined the mechanisms by which the sector in question affects transport, recent trends, interactions with other sectors, key influencing factors and possible actions by actor.

The examination of the three detailed case studies revealed the complex interactions between the various factors and external sectors, and the mechanisms by which transport demand is affected. It showed that there is a need for context specific instruments to be applied to tackle the effects of transport demand

rather than a long list of generic actions. However, a few fundamental findings were identified as being important to manage transport demand.

First, actors outside the transport sector need to understand and account for the consequences of their actions on transport demand. A review of the effectiveness of Impact Assessment Tools taking transport effects into account may give further indications for effective policy instruments.

The study also highlighted a knowledge gap and a need for more research on the transport consequences of non-transport decisions. It has been observed that European experience of managing transport demand by non-transport sectors is often undocumented, insufficiently highlighted or stays within the national boundaries of the EU Member States.

For the specific case studies some observations were made as follows.

Concerning ***Food production and consumption*** transport was highlighted as an important element of the logistical chain from 'farm to fork', with the potential to influence emissions throughout the whole process of producing and consuming food. A wide range of factors, including purchasing power, perception of fashionable/healthy food, availability of foodstuff domestically, product expiration date, marketing, convenience and technological developments were identified as influencing transport demand.

Some actions were identified such as the further promotion of food labelling to show its impact on greenhouse gas emissions, possibilities for manufacturers to use inputs from nearer subcontractors, encouraging consumers to take fewer shopping trips or to combine trips or journeys, using local shops, and to modify spatial planning policies to help make food shopping more convenient and associated journeys shorter.

Concerning ***Short-haul air travel for business and leisure*** air passenger demand and emission growth were found to be faster than for other transport modes. Both the business and leisure sectors are increasing their dependence on air travel. Businesses increasingly locate in close proximity to airports and airports have developed from simply being transport hubs to incorporate retail, conference/meeting and accommodation facilities. Key factors that influence air travel demand include disposable income, ticket prices, planning policies that favour regional airport development, availability of alternative modes and image/status of flying.

Accessibility to the wider European and global market was described as a large factor for the reliance of businesses on aviation. The development of alternative technologies such as remote conferencing and online meetings that could serve similar functions, and thereby reduce the need to travel physically have so far shown to often be compliments to travel rather than substitutes.

Actions can be taken at several levels to manage the increasing demand for air transport, such as the use of EU-ETS and other pricing mechanisms, promotion of alternative modes such as rail, further development and use of alternative technologies such as teleconferencing and increased efficiency of airplanes.and operations.

Concerning ***Education based travel effects on transport demand,*** trends across Europe indicate an increase in journeys to school by car caused for instance by concerns over children's safety and security, adults' travel behaviours and household income.

Actions to meet this trend include a denser network of primary schools and more aggregated schools with sustainable transport infrastructure for walking and cycling in such a way that children would be safer on the road. School travel plans, 'walking buses' and car pooling schemes may also be implemented.

The detailed case studies have highlighted the importance of systematically understanding the complex ways in which external factors and sectors affect transport demand. A few ***common issues*** were identified, which are relevant in meeting the challenge of managing transport demand and creating a more sustainable transport sector:

- Policies on transport demand are most effective when formulated under realistic assumptions regarding their effects on transport demand, and decided upon at the optimal level of governance.
- The long term and wider implications of non-transport policies need to be considered.
- The ancillary benefits of managing transport demand should be highlighted.
- Revenue from increased taxes (e.g. to internalise the external costs of transport) could (by political decisions) be channelled wherever appropriate to projects that decrease transport growth.
- Marketing of policy is thought to be important as well as the timing of implementation.

1 Introduction

Objectives and scope

The study has been prepared to screen and analyze selected external transport growth demand drivers in relation to the intensifying pressures on the sector due to its growing contribution to greenhouse gas emissions. The sector is faced with the challenge of sharply reducing its contribution to greenhouse gas emissions to meet Post-Kyoto targets and to reduce its other impacts on the environment.

To date policy action within the transport sector has tended to focus upon instruments and actions relating to energy efficiency and infrastructure, which are both in the realm of its competence and control. This study aimed to look beyond the transport sector to analyse the real causes of transport demand and to identify the major drivers, which are placed outside the transport sector, such as in the daily life and functions of other economic and social sectors and their activities. A better understanding of the causes could increase options for tackling the problems associated with increasing carbon emissions.

The overall aim of the study was to identify some main drivers of transport demand — mainly from a European perspective and to develop initial ideas for managing the demand whilst decreasing the size of the sectors carbon footprint. In order to achieve this aim the causes for transport demand were screened. The study is an input to the discussion on how to achieve an environmentally sustainable transport system in the future and of how to tap into the opportunities for non-transport sectors to support this. The study provides examples through case studies of the systems inside and outside the transport sector and of possible actions that could be taken by actors such as consumers, producers or governments. Both passenger and freight transport are being analyzed though one of the key assumptions is that drivers behind those two fields are different.

What is transport demand?

Demand in this case refers primarily to the product of distance and volume of people and goods carried. In other words, our foremost concern is how much people want or have to travel, and how much demand there is for goods to be carried around. It is to be noted that this definition of demand is a narrow one — how we travel (modal choice), when we travel (timing), how long we spend travelling (duration of travel) and by which route we travel (route choice) are closely linked issues which need to be understood to form a better picture of transport demand. Reference to these issues will be made within the study wherever appropriate and most relevant.

Historically, the demand for transport has been examined by placing the transport sector at the centre of the analysis, and by seeking variables that explain the observed changes to transport patterns. However, transport demand and growth are often created by decisions and developments outside the transport sector; transport is more often a means to an end, such as shopping, working and holidaying. Therefore, our approach aims to make explicit the external sectors and factors that drive transport demand.

This study helps to understand what creates transport demand and drives transport growth, which the transport sector is pressured to accommodate. It applies an expert transport perspective to non-transport drivers and an economic understanding of the economic and social needs of society.

The study focuses on the influences on transport demand from outside the transport sector. It is, however, difficult to completely separate transport and non-transport related measures and actions when it comes to finding ways to tackle increasing greenhouse gas emissions, noise and transport infrastructure. In this study transport infrastructure is itself seen as a driver for transport demand as new infrastructure leads to more induced traffic, which attracts more users. The study identifies the effects that new tourism strategies or business models, for example, can have on transport and demand for transport infrastructure. In order to tackle the problem, it is therefore necessary to have an understanding of the drivers outside the transport sector and to identify the role that transport can play. However, 'the end of pipe

solution' is part of an overall mix of action to tackle the carbon challenge.

Contents

To fulfil this aim the Study is divided into five chapters.

The Introduction (Chapter 1) presents the context of the study, provides a brief overview of the issue of transport demand management, the aims of the study and structure of the report.

In the Background (Chapter 2) the basic assumptions behind transport demand and its drivers are discussed and the framework to understand drivers is presented. It points out the linkages between transport and climate change, which is a key driver of the attempts to increase and encourage other sectors to join in and support transport sector in its activities towards the reduction of CO_2 and other greenhouse gas emissions. Increasing trends of transport demand and development reinforce the importance of looking beyond technological and supply side improvements. Lastly, it provides an understanding of the external drivers of transport demand.

The framework of analysis for the purpose of the study is presented in the Methodology (Chapter 3). It also details the purpose and extent of the literature review. The role of the short and long case studies is presented along with the reasoning behind the case study selection and focus.

The detailed case studies presented in Chapter 4 discuss in detail specific external drivers. They touch upon freight and passenger transport sectors including air and road transportation. The external drivers focus upon the areas of food production and consumption, tourism, and education, which provide a good example of the relevant economic and social issues.

Chapter 5 contains the conclusions drawn highlighting key messages and observations developed during the project.

The annexes provide supplementary material including the literature inventory (Annex A) and the nine short case studies (Annex B), which acted as an important basis for the discussion and conclusions drawn within the report.

2 Background

2.1 Transport and climate change

The transport sector is a major contributor to a large number of environmental problems, including air pollution, noise, vibration and community severance (see Figure 2.1). Of particular concern is the large and growing effect of transport on climate change.

In the EU (all current 27 Member States) total greenhouse gas emissions in 1990 were 5 572 Mt CO_2-equivalent, falling to 5 143 Mt CO_2-equivalent in 2006 (a decrease of 7.7 % ([1])). In the same period, emissions from the transport sector increased by 26 %, contrasting with other sectors such as energy supply and industry which have reduced their carbon footprint during the same period. In 2005 the transport sector represented 22 % of total EU greenhouse gas emissions (EEA, 2008a).

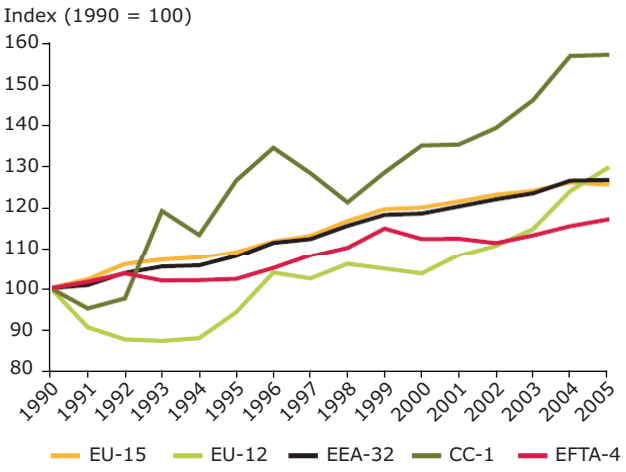
The EU has stated that to keep the impacts of climate change at a manageable and adaptable level, global temperature should not exceed the pre-industrial level by more than 2 °C. To help achieve this target, developed countries and regions, including the EU, are encouraged to reduce their emissions by 60–80 % over the period between 1990 and 2050 (EEA, 2008a). At its meeting in October 2008 the Council of Environment Ministers noted the information from IPCC that there was a need for developed countries to reduce their greenhouse gas emissions by 80–95 % by 2050 compared to 1990 levels.

The UNFCCC meeting in Bali in December 2007 culminated in a 'Bali roadmap' with the aim to achieve a new global agreement on reduction targets by the end of 2009. The agreement would include both developed and developing countries, but with the largest emission reduction effort expected by developed countries (indicatively in the range of 25 to 40 % emission reductions by 2020 from 1990 levels).

As a short term target the European Council on 7 March 2007 decided that EU should reduce its greenhouse gas emissions by 30 % between 1990 and 2020 if there was an international agreement and by 20 % if no such agreement is reached (EU, 2007).

To meet this, it is clear that the transport sector needs to substantially reduce current CO_2 emissions.

Figure 2.1 Transport is a major and growing emitter of carbon emissions



Source: EEA, 2008a.

2.2 Trends in transport demand

Transport demand is the expression of transport needs in terms of infrastructure (capacity), services (frequency) and networks. Transport demand is usually expressed in terms of number of people, volume, or tons per unit of time and space.

For passenger transport, transport demand is strongly linked to the changing nature of activities that necessitate transport, such as holidaying, shopping and commuting to work. Growth in freight transport volume has historically been strongly coupled to growth in gross domestic product, albeit with some regional differences within the EU. During the last decade, freight transport grew faster than GDP in the EU-15 reflecting the development of the single internal

([1]) Note: this excludes bunkers (176 Mt CO_2-equivalent in 1990 and 305 Mt CO_2-equivalent in 2006).

market, but slower in the EU-10 due to economic restructuring and a shift from traditional heavy industries towards the service sector (EEA, 2008).

Measured by the conventional scale of passenger-kilometres and tonne-kilometres, the EC predicts that transport activity will nearly double for both passenger and freight transport between 1990 and 2020 (EC, 2007b) (see Figures 2.2a and 2.2b).

For freight traffic, growth is expected to be strongest for road based surface transport (i.e. lorries), whereas for passenger transport, private road transport (cars) and aviation will see the largest increase.

Car ownership levels have grown across Europe, but particularly in the Central and Eastern European states, which are now converging towards a similar ownership level to countries in Western Europe. For example in Lithuania, car ownership grew from 198 cars per 1 000 inhabitants in 1995 to 428 in 2005 (EEA, 2008).

Aviation is the fastest growing mode of passenger transport. Total growth in EU air transport was 49 % between 1995 and 2004 (25 Member states), and is forecast to grow at roughly 4–5 % per annum for the foreseeable future ([2]). The bulk of these emissions increases are due to international aviation, which is excluded from consideration under the Kyoto Protocol and, for the time being, is also outside the scope of agreed EU emission-reduction targets (EEA, 2008).

Europe is therefore presented with the difficult question of how to reduce carbon emissions in the face of ever-increasing transport demand.

2.3 Beyond technological and supply-side improvements

If transport volume is allowed to increase as predicted, the remaining option for reducing carbon emissions from the sector would be to rely on improvements in operational and technological efficiency. In other words, emissions by passenger or tonne kilometre would need to decrease faster than the increase in transport activity. This would be achieved by a combination of improved loading factors, a shift towards public transport, and better energy efficiency for vehicles. However, the above changes seem unlikely to be sufficient to offset increases in demand when past trends are examined.

As shown in Figure 2.4, the energy efficiency of cars has improved by roughly 10 % between 1990

Figure 2.2a Passenger transport demand growth projections (Gpkm)

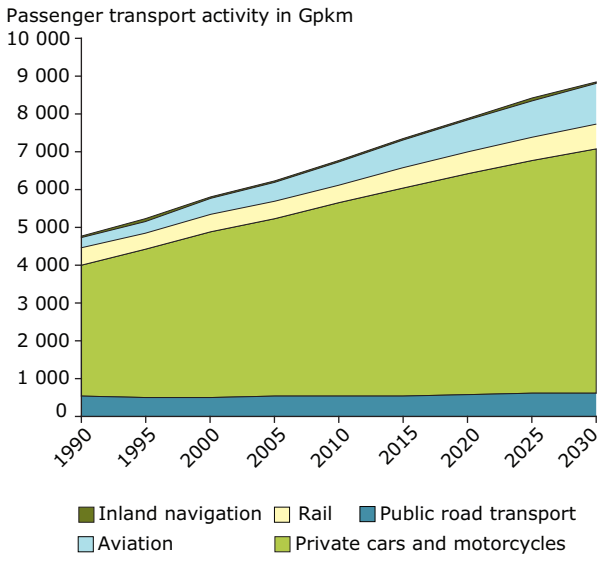
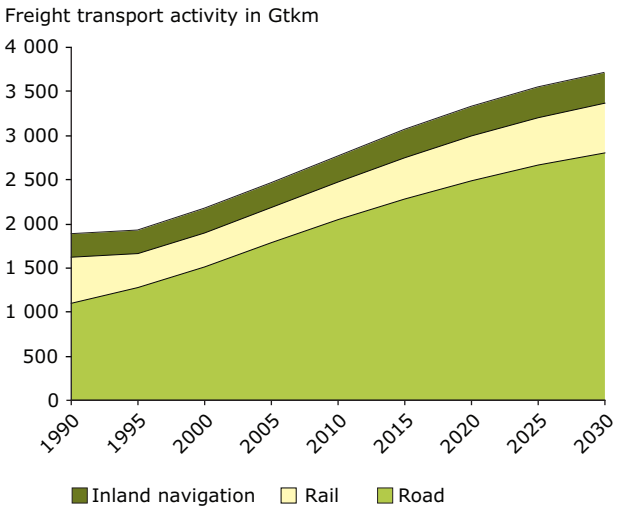


Figure 2.2b Freight transport demand growth projections (Gtkm)

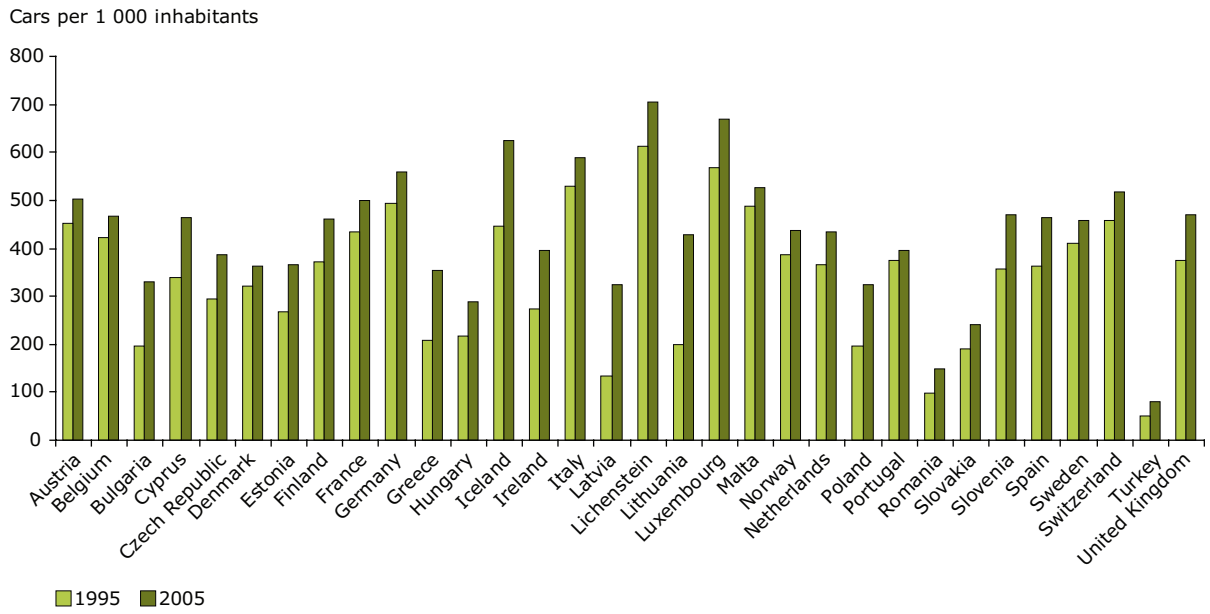


Note: Excludes extra-EU (international) aviation and shipping.

Source: EC, 2007b.

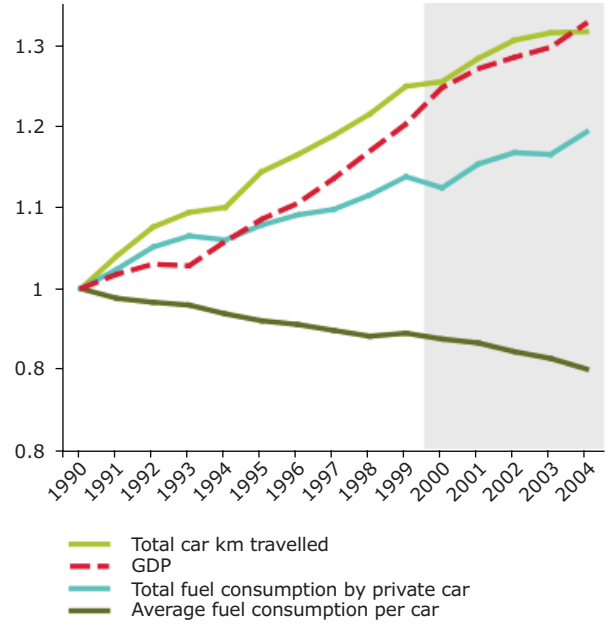
([2]) Due to the recent increases in oil prices and the economic slowdown, air fares are expected to rise and aviation demand is expected to slow, at least temporarily. However, the long-term trend is likely to remain upwards.

Figure 2.3 **Car ownership levels are increasing, especially in Central and Eastern European countries**



Source: EEA, 2008a.

Figure 2.4 **Efficiency improvements have not been sufficient to offset growth in transport demand**



Source: EEA, 2007a, 1990 = 1.

and 2004. However, this has not been sufficient to offset the above 30 % increase in car travel demand, resulting in increased total fuel consumption of approximately 20 %.

Improvements in engine technology are not meeting the levels set in the voluntary commitments by the automobile industry (e.g. ACEA, JAMA and KAMA) to reduce the average emissions of new cars from an average level of 186 to 140 g CO_2 per kilometre by 2008/09 (see Table 2.1). Although there have been efforts by manufacturers to improve the fuel efficiency of their cars, there has also been a steady increase in the size, weight and power of the vehicles demanded in the market. As a consequence, the overall fuel efficiency of new vehicles only improved by 10 % on average between 1990 and 2004. The European Commission has proposed binding targets for CO_2 efficiency for new cars. In December — 2007 it presented a legislative proposal to reduce the average CO_2 emissions of new passenger cars in the Community to 120 g CO_2/km through an integrated approach.

There is also the related problem of the so-called 'rebound effect' where efficiency improvements translate into financial savings for the end consumer (i.e. less money spent at the pump), and thereby increase the incentive for people to drive longer, or faster. In other words, the gains in efficiency are partly offset by an increase in the demand for fuel. It is commonly estimated that the magnitude of the rebound is between 5 to 30 % ([3]) (UKERC, 2007).

The development and use of alternative fuels including biofuels is an option to reduce greenhouse

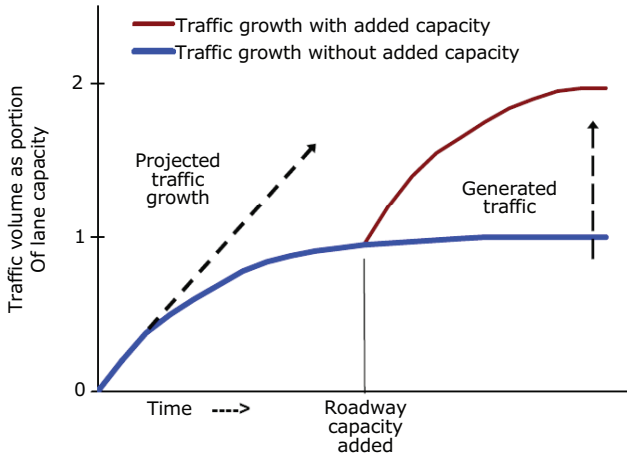
([3]) In other words, 5 to 30 % of the savings due to efficiency increases are reduced by the extra increase in the demand for fuel.

Table 2.1 Voluntary targets by manufacturers have not been met

Year	G CO_2/km			
	ACEA	JAMA	KAMA	Total
1995	185	196	197	186
2000	169	183	191	172
2004	161	170	168	162
2005	160	166	167	161
2006	160	161	164	160
Target	140 g/km by 2008 and 2009			

Source: T&E, 2007 and EC, 2002.

Figure 2.5 Conceptualisation of the generation of traffic through increased road capacity



Source: VTPI, 2007.

gas emissions in the transport sector. Hydrogen could play an important part in a long term perspective (25–30 years) but is not likely to make a significant contribution in the near to long-term timeframe.

Their contribution in the future will depend on many factors, including technological development and possible secondary negative environmental and other effects.

Supply side improvements, such as the elimination of bottle necks and improving the road network, have also shown limited, if not negative, results in terms of solving the negative impacts of excessive transport demand. For example in the United Kingdom, the Standing Advisory Committee on Trunk Roads (SACTRA) pointed out in 1994 that building new roads is likely to result in the generation of new traffic, as travel by car is effectively made more attractive (e.g. through reductions in travel time).

Figure 2.5 shows the concept of generated traffic through increased road capacity, whereby building new roads or extending existing ones creates an incentive to drive more.

In short, there is a limit to which we can expect technological and supply-side measures to tackle transport emissions on their own, although their careful use can make a significant contribution to making the sector more sustainable. It is for this reason that measures to manage and reduce demand must play a larger role.

2.4 Managing demand for a sustainable transport system

The ever-increasing demand for transport activities raises large concerns regarding the sustainability of our transport system. Apart from greenhouse gas emissions, negative impacts are observed through poorer air quality, noise, increase in traffic accidents, reduction in green spaces and loss of community cohesion. Transport is also linked to the loss of biodiversity, consumption of natural resources and pollution of water sources. Questions are also raised regarding current attitudes and practices by transport practitioners and policy-makers, and their ineffectiveness in managing demand.

As Banister (2008) and Metz (2008) point out, transport planning and policy currently focus on minimising the cost or burden of the transport activity ([4]). In particular, emphasis is given to travel time savings as this is thought to constitute a large proportion of the overall costs of travelling. Public

([4]) In jargon, this is known as the generalised cost of travel and is composed of financial costs, time costs, discomfort and other elements that may be perceived by the user to be costs.

projects which enable more people to reduce their journey time have traditionally been favoured, such as the development of major trunk roads. This is often in conflict with other social objectives which policymakers may be interested to pursue, such as safeguarding the environment and reducing traffic accidents (see Banister, 2008).

However, as Blijenberg (2002) and Metz (2008) illustrate, there is evidence to suggest that people are consistent in the time they allocate to travelling (roughly 1 to 1.1 hours per day), both across time and across countries/regions with different levels of income (Figure 2.6). This phenomenon is commonly known as the constant travel time budget. Therefore, transport developments which seemingly produce journey time savings at first are likely being offset by physically longer journeys at higher speeds, leaving journey time per day relatively constant.

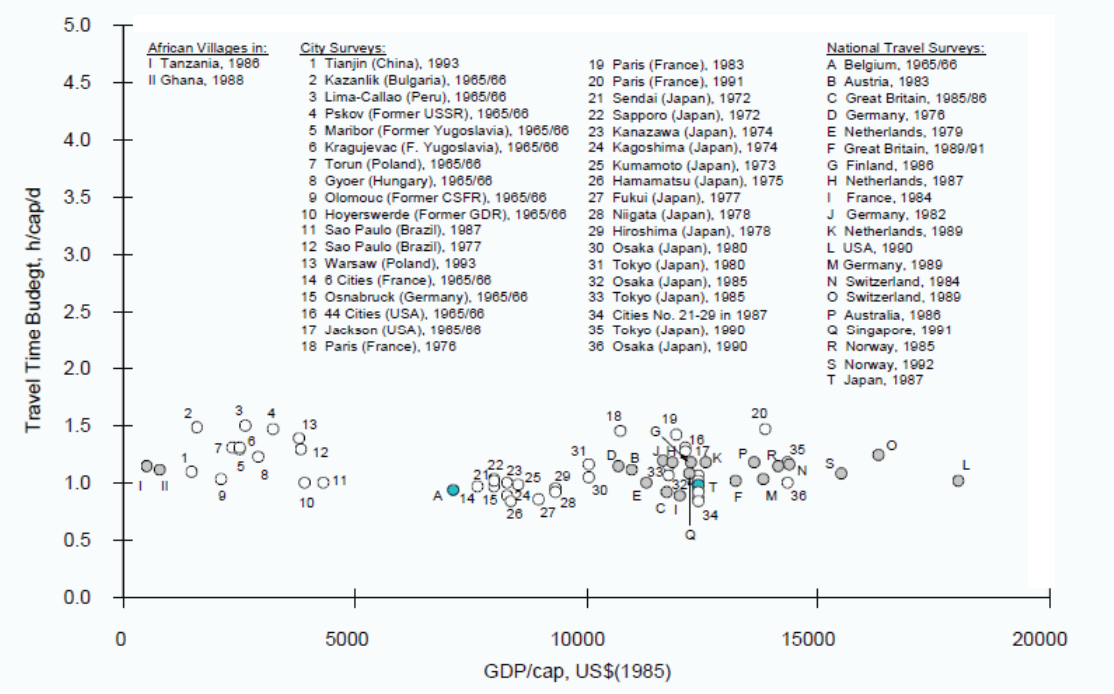
As a result, people seem to have access to a larger number of destinations, be they workplaces, shopping malls or schools. However, Metz (2008) argues that the value of extra destinations may diminish with scale; the ability to access three supermarkets is marginally more fruitful to the average person compared to the access of the fourth supermarket. In other words, the value of extra access may in fact grow slower than the increase in transport demand. Social values are closely related to how the accessibility of destinations is perceived. On one hand, one may observe a continued desire for more choice, whereas on the other, there could be a shift towards a community-oriented lifestyle (see Annex B-9).

The above issues highlight the problem of considering transport benefits in isolation to the actual activity that is enabled by it. Focusing on enhancing transport benefits in the traditional sense is thought to aggravate the problem of increasing demand ([5]).

2.5 Understanding the external drivers of transport demand

The demand for transport is often described as 'derived' from the needs and wants for other activities. Rarely is travelling done for its own sake;

Figure 2.6 Constant time budget



Source: Blijenberg, 2002.

([5]) Kennedy *et al.* (2005) and Banister (2008) advocate a shift in the way transport is planned, with an emphasis on accessibility as opposed to mobility. Focus would be shifted from moving traffic, to how people can access essential facilities.

people travel to get to work, commute to school and shop for goods (see Figure 2.7). It is therefore natural that transport demand is influenced by decisions and developments in sectors external to transport, such as business, education and retail.

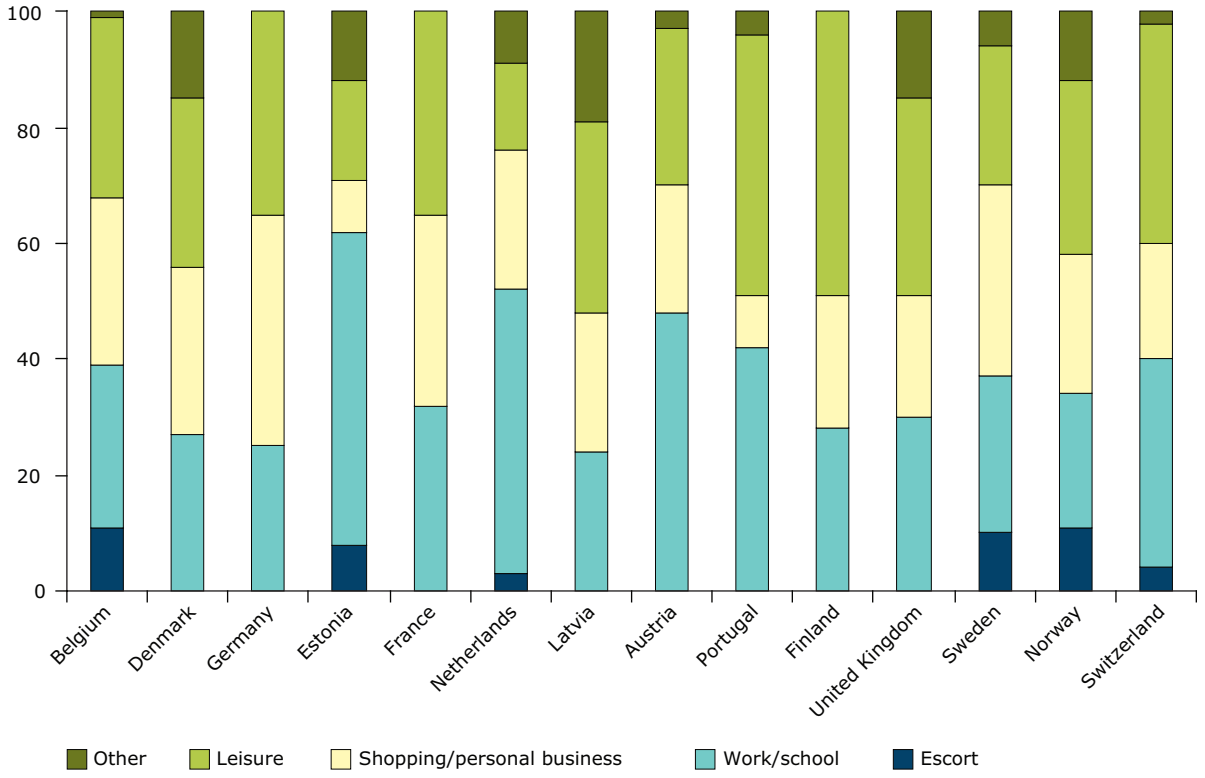
Furthermore, all sectors including transport are subject to influences from a range of economic, social, spatial, cultural and technological factors. Rarely do these factors impact on a single specific sector. For instance, changes to an economic factor such as a rise in income affect the quantity and quality of grocery consumed, where people spend their holidays, where parents send their children to school, and where to work.

The observed changes in transport demand are a result of a complex and often intangible combination of these sectors and factors. In the example of grocery consumption, the spread of new technologies such as e-commerce can fundamentally affect how we shop for goods, as online shopping and delivery substitute the traditional journey to the supermarket. Quantifying the effects of such developments on transport demand is difficult, as there are often trade-offs being made between types and frequency of journeys. In this case, reductions in car trips to the supermarket are compensated by delivery vans making (often more frequent) journeys to individual homes. The challenge is to ensure that the new technology improves the energy efficiency of the entire logistical chain, from production source to the consumer (see Annex B.1).

Changes to the factors that affect the various sectors (and hence transport demand) are often long term and common across a wide geographic area. For instance, the demographic trend seen across Europe highlights an increasing proportion of elderly, economically inactive citizens over the age of 65. This may contribute negatively to the total demand for work and business related travel, whilst at the same time increase leisure trips by car, especially if public transport and other means of travel are not suited to the added mobility requirements of elderly citizens (see Annex B.4).

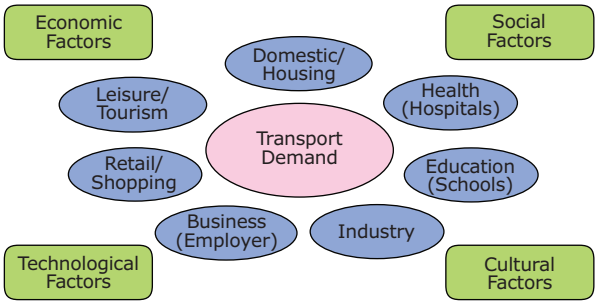
Large changes in political economy also impact on transport demand. For example, the recent enlargement of the European Union has resulted in a larger internal market, increasing the division of labour and level of specialisation across EU

Figure 2.7 Transport activities serve the needs and wants for other activities



Source: EC, 2007a.

Figure 2.8 Transport demand is influenced by a range of external sectors and factors



countries and regions. Combined with a general shift away from traditional heavy industries across the region, total freight transport volume by road has increased substantially, offsetting the decline in rail-based freight transport (see Annex B.5).

The above points highlight that in all cases, transport demand is influenced by a multitude of external factors and sectors. The direction and magnitude of change in demand depends on the complex balance between these influences. This study, through the methodology explained in the next chapter, aims to develop a comprehensive and sound understanding of the external sectors and factors, and the mechanisms by which transport demand is affected.

This will then enable a discussion of how the various sectors depending on transport, or increasing their dependability on transport, can contribute to the reduction of greenhouse gas emissions and other negative environmental effects caused by the transport sector. By identifying the external sectors and factors with the largest impacts on transport demand, targets aimed at reducing emissions from the transport sector can become easier to achieve.

3 Project methodology

This chapter explains the methodological approach employed in this study to understand the external drivers of transport demand. The approach combined the formulation of a conceptual framework, a literature review of the existing knowledge and evidence, the identification of relevant topics as case study candidates, and in-depth analyses of three case studies. An attempt was made to draw upon the existing literature, but also to provide new interpretations from the viewpoint of understanding the drivers of transport demand. A balance was also struck between theoretical robustness and practical relevance. An overview of the main steps is provided in Figure 3.1, and a brief explanation of each step is provided in the following sections.

3.1 Building a conceptual framework

Historically, the demand for transport has been examined by placing the transport sector at the centre of the argument, and seeking explanations for the observed changes to transport patterns. This is particularly true for the majority of quantitative models, which are based on statistical analysis such as regression which aims to identify significant factors that explain changes to transport demand. These models are advantageous in their ability to predict the effects of changes in one variable (e.g. income) on certain aspects of transport demand (e.g. kilometres driven by car).

The disadvantage of such an approach however, is that it largely limits the perceived relevance of the information, as well as the distribution of knowledge, to those familiar with the transport sector. The traditional approach is also limited as far as making explicit the links between sectors external to transport, for example health, education or housing, to transport activities.

This will then enable a discussion of how the various sectors depending on transport, or increasing their dependability on transport, can contribute to the reduction of greenhouse gas emissions and other negative environmental effects caused by the transport sector. By identifying the external sectors and factors with the largest impacts on transport demand, targets aimed at reducing emissions from the transport sector can become easier to achieve.

It was therefore decided that an alternative approach should be followed, which would start from the identification of factors and sectors external to transport, and then assess their potential and actual impacts on transport demand. This approach is summarised in Figure 3.2, which shows a three-step process of identifying the various factors, linking them with the relevant sectors, and assessing their impacts on transport demand.

Figure 3.1 The flowchart of study's methodological steps

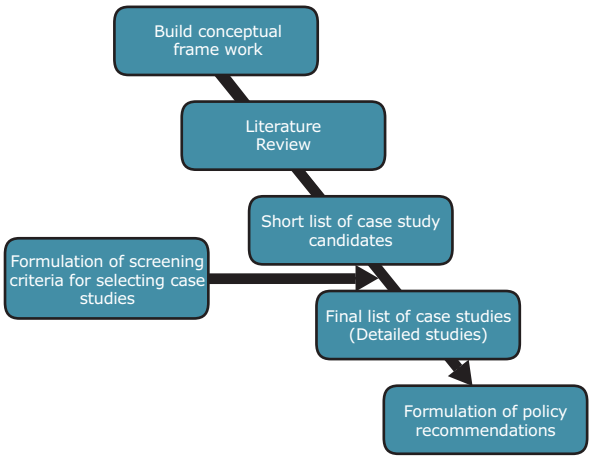
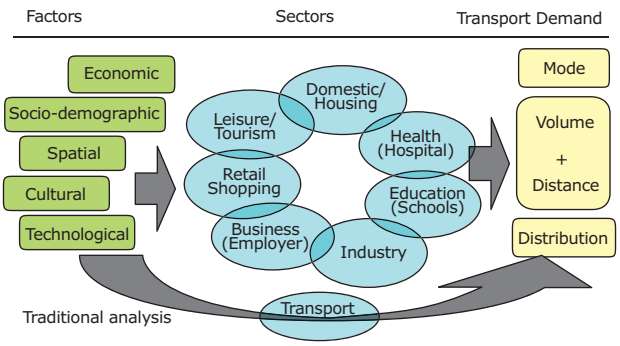


Figure 3.2 Conceptual framework of transport demand analysis



The factors that were considered were as follows:

- **economic** — such as income, prices of goods and services, taxes, subsidies, macroeconomic policy, industrial structure and marketing;
- **socio-demographic** — including population, household size, age distribution, gender roles, labour participation, ethnicity and migration;
- **spatial** — including population density, land use, planning and major infrastructure;
- **cultural** — including attitudes, values and lifestyle;
- **technological** — including developments in mechanical, physical and information technology.

These factors were thought to affect the developments and trends in various sectors in the economy, including:

- **education** — such as schools, universities and other educational institutions;
- **industry** — both heavy and light;
- **health** — such as hospitals;
- **energy** — such as energy generation and distribution;
- **business** — such as the service sector;
- **agriculture** — such as production, wholesale and retail;
- **domestic/housing** — primarily households.

For this study, energy was not treated as a sector, but was assumed to be an implicit technological factor that would affect any sector, including transport.

Finally, the interaction between these factors and sectors was linked to their impact on transport demand, which was mainly defined in terms of:

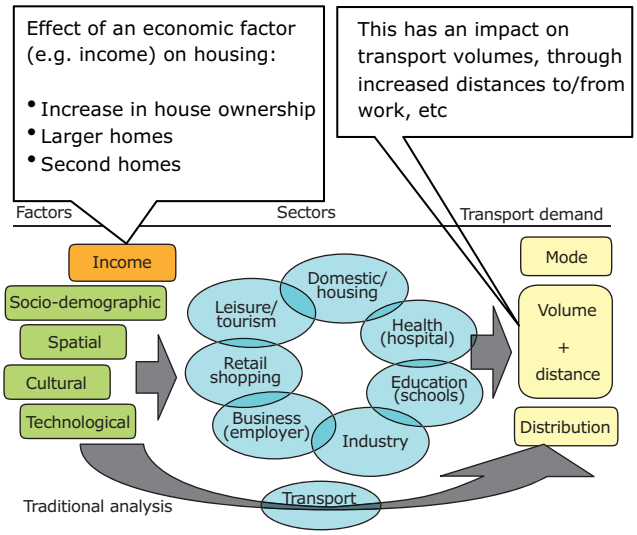
- **volume /distance** — or how much travel activity is being pursued ([6]).

The focus on volume and distance was based on the aim of the study to highlight how the sometimes 'narrow' definition of transport demand is augmented with the closely related issues of:

- **modal choice** — in what way the travel activity is being conducted.
- **distribution** — when and where the travel activity takes place.
- efficiency – how much energy is used per passenger/freight kilometre travelled.

A hypothetical example of how the factors and sectors interact to affect transport demand is given in Figure 3.3. Here, an economic factor, namely income, has grown to affect the domestic/housing sector. The extra income results in a greater level of house ownership (particularly in the suburbs), larger homes, and even second homes abroad. This produces impacts on transport demand due to people commuting longer distances to work, and using air travel to spend their free time in their holiday homes abroad.

Figure 3.3 Example of the interactions between a factor, sector and transport demand



3.2 Literature review

An extensive literature review was conducted of the existing evidence and knowledge on the various factors and sectors. The literature search encompassed a variety of methods and sources, including:

- TRL's Library and Information Centre Knowledge Base — which is a combination of a fully-searchable extensive library catalogue and the English language context of the ITRD (International Transport Research Documentation) database ([7]);

([6]) This is normally expressed in passenger-kilometres for passenger transport, and tonne-kilometres for freight transport.
([7]) For the formal search conducted in TRL's Knowledge Base, the following search terms were used – 'General' (transport, demand, growth, drivers, sectors, factors) and – 'Combined' (transport AND demand AND…): housing, energy, education, health, industry, telecommunication, agriculture, domestic, business, location, land use.

- academic databases — including Science Direct, Ingenta Connect, and Routledge;
- European and international agencies — including the European Environment Agency (EEA), European Commission (EC), European Bank for Reconstruction and Development (EBRD), Organisation for Economic Cooperation and Development (OECD), the International Energy Agency (IEA), the International Transport Forum (ITF, formerly ECMT), the World Bank, the United Nations Environment Program (UNEP), and the United Nations Development Program (UNDP);
- relevant ministries, local authorities and other official bodies of EU member states — including official publications and policy statements on the relevant topics analysed in the report, in particular for the detailed case studies;
- other grey literature — including unpublished academic papers and newspaper articles.

The search mainly covered literature published after 2000, and identified more than 60 items of relevance. Similar search phrases were used to search for relevant information from the other sources mentioned above. Each literature source was examined for relevance to the topic of the study, and was included in the literature inventory if it was judged to be appropriate.

The search results were summarised in a 'literature inventory', which organised information regarding the regional scope, type of transport (passenger versus freight), mode, sectors and factors covered in each publication. An overview of the inventory is provided in the Annex to the present study.

Additional searches were then conducted in order to augment the information identified from the initial search. This was particularly the case in developing the detailed case studies.

3.3 Selection of the case study candidates

The literature review resulted in a pool of literature sources addressing the (external) sectors and factors driving transport demand. The broad sectors identified were:

- trade/retail shopping and distribution of food products and goods;
- leisure and tourism (only for passenger transport);
- built environment and land use, including education, business/work and telecommunication (only for passenger transport);
- industry — manufacturing (only for freight transport).

It is important to note that the sectors identified roughly correspond to the main journey purposes conventionally used in the transport sector, which are:

- shopping;
- leisure;
- work and education (including escorts);
- freight.

At this point, an attempt was made to identify the mechanisms by which the identified sectors influence transport demand. Table 3.1 presents a qualitative assessment by the authors of the correlation between the external sectors and various aspects of transport demand (i.e. infrastructure, services and networks).

Some of the factors that were discussed in the previous section were picked up in the literature, the main ones being:

- **socio-demographic trends** such as the ageing of the population and changes to social values;
- **economic globalisation** resulting in increased world trade and movement of people, as well as the further integration of the EU member states;
- **physical changes** to urban form;
- **organisational changes** to the planning and management of transport activity, especially around companies and schools;
- **technological developments** such as the expansion of information and communication technology (ICT).

This resulted in a matrix of sectors and factors, as depicted in Table 3.2 overleaf. Nine topics were identified from within this matrix for consideration as potential case studies. Those were:

1. the effects of E-Commerce on shopping journeys;
2. effects of food production and consumption on shopping journeys and freight traffic;
3. the increasing use of short-haul air travel for business and leisure travel;
4. demands of an ageing population on leisure trips;
5. changes to industrial structure after EU expansion and their effects on freight traffic;
6. the relationship between urban form and transport demand;
7. influencing commuter choice through company management;
8. education based travel effects on transport demand;
9. changing social values and its effects on transport demand.

Table 3.1 External sectors and their relationships with transport demand

	External sectors (*selected*)			
Transport demand	**Built environment ([8])**	**Industry/ manufacturing ([9])**	**Tourism**	**Trade/retail**
Passenger transport				
Volume/distance			High	High
Number of trips	High		High	High
Trips length	High		High	High
Vehicle occupancy	High			
Mode				
Non-motorised	High		Low	Low
Private road (car)	High		Medium	High
City/public tansport	High		High	High
Rail	High		High	Low
Shipping	Low		Medium	Low
Aviation	Low		High	Low
Distribution				
Timing	Low		High	High
Location	High		High	High
Freight transport				
Volume/distance				
Number of trips		High		High
Trips length		High		High
Load factor		High		High
Modal split				
Road		High		High
Rail		High		Medium
Shipping		High		High
Aviation		Low		Low
Distribution				
Timing		Medium		Medium
Location		High		High

Note: This table illustrates the relationship between external sectors and transport demand. The Red, Amber and Green ratings show the magnitude of the (potential) impact of the external sectors on the various components of transport demand in absolute (and not marginal) terms. The focus is on emissions caused directly from the transport activity, and does not include anticipatory process emissions. Efficiency of vehicles is not included, in order to focus on non-technological aspects.

The above nine case study candidates were selected with the intention of covering as wide a range of sectors and factors as possible, although the list was in no way an exhaustive list of cases to examine.

Each of these nine case study candidates were briefly assessed on the way in which they affect transport demand, and potential ways in which actors could manage the situation to reduce demand. This information was summarised in a concise one-page layout, and is available in Annex B for reference. The layout was adopted to provide an easy source of reference for transport practitioners, professionals outside the transport sector and the general public alike. Each case starts with a summary table, an example of which is shown in Table 3.3.

([8]) Considered only for passenger transport.
([9]) Considered only for freight transport.

Table 3.2 Candidate case studies within the matrix of sectors and overarching factors

Overarching factors/sectors	Socio-demographic changes	Economic globalisation	Physical changes	Organisational changes	Technological developments
Shopping		2. Effects of food production and consumption on shopping journeys and freight traffic			1. The effects of e-commerce on shopping journeys
Leisure	4. Demands of an ageing population on leisure trips	3. The increasing use of short-haul air travel for business and leisure travel			
Business/ commute				7. Influencing commuting journeys by corporate management	
Education				8. Education based travel effects on transport demand	
Industry		5. Changes to industrial structure after EU expansion and their effects on freight traffic			
All	9. Changing social values and its effects on transport demand		6. The relationship between urban form and transport demand		

Table 3.3 Example summary table for case study candidates

Mode of transport
Freight (production source to outlet)
Passenger (shopping)
Sectors
Trade, retail
Factors
Economic, technological, cultural

Criteria	**Score**	
Carbon reduction potential	Short	Low
	Medium	Medium
	Long	Medium
EU policy influence	Weak	
Cost effectiveness	High	
Political/social acceptability	Medium	

Note: The table agglomerates information regarding the mode of transport, the sectors being covered, and the major factors that affect it. Furthermore, the topic is assessed by the criteria mentioned in the next section, including the potential for carbon reduction (in the short, medium and long term), EU policy influence, cost effectiveness, and political/social acceptability. Results of the qualitative assessment are provided as a red, amber or green score.

3.4 Selection of case studies for further examination

The previous section explained how nine case study candidates were identified from a matrix of sectors and factors. This section outlines the process of selecting the case studies for further examination.

In selecting the case studies, the following criteria were applied to each of the candidates:

- **Potential for change** — analysis targeted sectors which can produce the biggest effect in terms of reducing transport demand and therefore reducing greenhouse gas emissions. Potential for reduction was assessed for the short (<2 years), medium (2–10 years) and long term (10+ years). The criteria assisted in identifying the sectors and transport modes which contribute the most to CO_2 emissions, and which, targeted by policy measures, can therefore lead to the biggest reductions in CO_2.

- **EU policy influence —** in terms of whether the issue needs intervention on the European level. The EC does not need to act if better and more efficient results can be achieved through national and local level policy-making. Therefore the criterion was used to highlight areas where without policy intervention on the European level, CO_2 reduction is unlikely to occur.
- **Cost effectiveness —** how costly it is to achieve a unit of CO_2 reduction. Preference was given to measures that promise 'better value for money'. Costs in this context included public as well as private resources. Analysis of cost effectiveness relied on the availability of the evidence in the literature. Only rough estimates have been used.
- **Acceptability —** political and social acceptability of main measures to address the negative effects of each issue. The criterion helped to identify those measures which are most likely to receive political and public support.
- **Availability of literature and data —** based on the results of the literature review (internet sources, TRL library and Oxford University recommendations).

Additionally, consideration was given to provide a wide coverage of:

- sectors and influencing factors, as identified previously;
- major stakeholders with the potential to affect transport demand and travel behaviour; and
- both passenger and freight transport.

Table 3.4 shows the results of the application of the above criteria to the nine case study candidates. The qualitative assessment was mainly conducted using the information available from the literature review. In some cases, where concrete evidence was missing, judgement was made through expert consultations and/or through comparative analysis between the various topics to ensure consistency and minimise bias.

From the nine candidates, three (Candidate 4 — Demands of an ageing population on leisure trips, Candidate 7 — Influencing commuter choice through company management, and Candidate 9 — Changing social values and its effects on transport demand) were ruled out on the grounds of inadequate literature and data. This does not imply that these cases are unimportant — further research in these areas is likely to prove useful in the future. Candidate 6 —The relationship between urban form and transport demand was not selected for the opposite reason that a large level of effort has already taken place to assess this issue on a European level (e.g. through multi-year research projects such as SESAME, PROPOLIS and SOLUTIONS). Readers are therefore advised to consult the reports from these studies for further information.

The remaining five candidates cover the trade/retail sector (Candidate 1 — The effects of e-commerce on shopping journeys, and Candidate 2 — Effects of food production and consumption on shopping journeys and freight traffic), business and tourism (Candidate 3 — The increasing use of short-haul air travel for business and leisure travel), industry (Candidate 5 — Changes to industrial structure after EU expansion and their effects on freight traffic) and education (Candidate 8 — Education based travel effects on transport demand).

Candidate 3 was selected because of the dominance of 'high' scores for most of the criteria. Candidates 1, 2 and 5 contained a freight element, from which Candidate 2 was chosen because of its superior scores compared to candidate 1, and larger coverage of issues (passenger and freight, trade and retail) compared to Candidate 5. Candidate 8 was chosen because of the potentially high impact in the long term, and the usefulness in highlighting an often neglected sector (education) by transport professionals.

The three case studies that were selected for detailed analysis are repeated below, together with a brief explanation on the reason for their choice.

Case 2. Effects of food production and consumption on shopping journeys and freight traffic — This case was selected to discuss both the freight aspect of delivering the goods from the production source to the retail point and the shopping journeys made by the consumers. It touches upon the increasingly debated issue of food miles and international trade of agricultural goods. The roles of industry and public bodies, such as the EU, are highlighted.

Case 3. Increasing use of short-haul air travel for business and leisure travel —This case study was selected to illustrate the various aspects of short-haul air travel, including journeys made for leisure purposes (e.g. weekend holidays and stag parties abroad) as well as those for business (e.g. migrant workers from Eastern Europe to countries such as Ireland and the United Kingdom, and international business meetings and conferences). The close link between increased air travel with the expansion and further integration of the EU are made explicit, together with the reduction of fares brought about by deregulation and the rise of low-cost carriers.

Case 8. Education based travel effects on transport demand — This topic was chosen to highlight the education sector, which is often neglected in terms of its relationship to transport. It also clarifies how stakeholders at a much more local level can work together with larger bodies such as national governments or the EU to promote non-car journeys to school.

The three detailed case studies are discussed in more details in Chapter 4.

Table 3.4 Application of criteria to the list of candidate case studies

	Candidate case studies	Sector	Transport mode	Main stakeholders	Criteria							
					Carbon reduction potential short (< 2yrs)	Carbon reduction potential medium (2–10 yrs)	Carbon reduction potential long (10 + yrs)	EU policy influence	Cost effectiveness	Acceptability	Availability of literature and data	Comments
1	The effects of e-commerce on shopping journeys	Trade/ retail	Freight and Passenger	Industry, central governments, EU	Low	Medium	Medium	Weak	High	Medium	Medium	Covers retail sector and private shopping
2	Effects of food production and consumption on shopping journeys and freight traffic	Trade/ retail	Freight and Passenger	Industry, central gov, EU, consumers	Low	Medium	Medium	Medium	Medium	Strong	Medium	Covers both freight and passenger transport for shopping journeys
3	The increasing use of short-haul air travel for business and leisure travel	Business/ tourism	Passenger	Industry, consumers, central gov, EU	Medium	High	High	Strong	High	Medium	Medium	May cover a range of issues e.g. migration, tourism, business
4	Demands of an ageing population on leisure trips	Tourism	Passenger	Consumers, industry, central gov	Low	Medium	Medium	Medium	Medium	Medium	Low	Evidence base is limited
5	Changes to industrial structure after EU expansion and their effects on freight traffic	Industry	Freight	Industry, EU	Low	Medium	High	Strong	Medium	Medium	Medium	Will need to limit scope in terms of industry/ location in EU
6	The relationship between urban form and transport demand	Land use	Passenger and Freight	Regional gov, local gov, central gov, EU	Low	Medium	High	Medium	High	Medium	High	Various EU studies already exist. May be difficult to add anything new
7	Influencing commuter choice through company management	Business/ tourism	Passenger	Businesses	Medium	Medium	High	Medium	High	Strong	Low	Evidence base is limited
8	Education based travel effects on transport demand	Education	Passenger	Schools, local gov, parents	Low	Medium	Medium	Weak	Medium	Strong	Medium	Case studies available from Barcelona, UK, Netherlands and Italy. May bring ancillary benefits e.g. safety
9	Changing social values and its effects on transport demand	All	Passenger	Public, media, schools, gov	Low	Medium	High	Weak	High	Medium	Low	Long term developments are hard to predict

4 Detailed case studies

This chapter explores the three detailed case studies that were chosen out of the nine topics identified from the screening of the literature inventory. These were:

(1) the effects of food production and consumption on shopping journeys and freight traffic;
(2) the increasing use of short-haul air travel for business and leisure travel;
(3) education-based travel effects on transport demand.

The first topic covers the increasing level of both freight and passenger traffic, resulting from an increase in the movement of foodstuffs worldwide.

The second topic deals with the problem of a rapid rise in air travel, triggered at least in part by the deregulation of the aviation market and the expansion of the European Union.

The third topic investigates the link between the education sector and transport, incorporating issues around road safety, physical health, and the environment.

Collectively, the three studies cover the sectors of retail, business, tourism and education. Various factors, including economic, social, cultural and spatial, will be shown to influence these various sectors, and thereby transport demand.

For each case study, a brief discussion on how it affects transport demand will be provided. Recent trends surrounding the topic will then be explored, focussing primarily on the European context, but also drawing from information further abroad, in case this adds to the understanding of the wider context. Interactions with other sectors will then be highlighted in an attempt to organise the complex relationships between sectors that may affect transport demand. An examination of the various influencing factors follows, focussing on those considered to be most important and relevant. Finally, some suggestions to address demand will be sought that take into account the limitations, barriers and future prospects of the identified topic.

4.1 Effects of food production and consumption on shopping journeys and freight traffic

Transport in the food production and consumption cycle is what we use to get food from 'farm to fork'. For the purpose of the study, transport demand in this cycle is the need for transportation of food stuff from farms to processing and packaging centres, transportation of processed products to storage or whole sales centres, transportation of packaging, the transportation to the markets and shops and the need for consumer to reach the sales outlet and to purchase the products. Additional transportation needs of the food production and consumption cycle are created by the need to dispose waste (processing and consumption, such as packaging), deliver fertilizers and other transportation needs of farming and processing activities, which are not discussed here, but would otherwise form entire cycle of food production and consumption.

With an expanding European market, globalisation of the economy and increasing demand for food, transports role, cost and impact on the environment in association with the 'food journey' is increasing. Food products are being delivered from more distant locations, they increasingly presented for sale in fresh rather than frozen or processed form and some times they travel long ways for processing necessitating additional transport needs because of distribution and costs of global labour market.

Transport is not the only source of greenhouse gases in the process of food production and consumption, however its share and the amount of greenhouse gas emissions generated in the overall food cycle is growing (DEFRA, 2006b). Other sources of greenhouse gas emission in food production and consumption relate to food production (i.e. agriculture), processing, cooling, packaging, storing and final preparation for consumption. The case study did not consider the impacts of transport of fodder and other agricultural products such as flowers or tobacco; however it looked into transport costs and effects of bottled water transportation.

The key means of transportation of food from farm to distribution centres are road freight transport, with the waterways' freight transport and rail following it. Table 4.1 shows the share of the transport for foodstuff (by mode) compared with other products in some EU countries. Although from the statistics below it is impossible to separate animal fodder and road freight transport of goods, the categories 0 and 1 constitute 18 % of all road freight. Categories 0 and 1 make up 8 % of goods transported by rail, and inland water transport carries 8.7 % of stuff related to food.

Every supermarket food product has a different transportation induced carbon footprint. A study developed by the Sustainable Europe Research Institute provided an example in Table 4.2 below of the carbon footprint of different fruits and vegetables sold in Austria based on their source.

Van Hauwermeiren, Coene, Engelen, and Mathijs's (2007) study cited in Saunders & Hayes (2007) compared energy and emissions between a variety of food supply systems. Across product categories analyzed (potatoes, lettuce, tomatoes,

Table 4.1 Total goods transport (national and intra EU), by group of goods, aggregate of available data, 2004 (million tonnes)

	NST/R chapters											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**	**% share**
Road	758	1 081	65	396	132	330	4 904	133	517	1903	10 221	91
Rail**	33	15	67	39	54	94	74	10	35	115	535	5
Inland waterways	16	25	49	80	51	16	143	11	34	43	469	4
Total	807	1 121	182	514	238	440	5 121	154	586	2062	11 225	100

Key to the table: 0 — agricultural products and live animals,
1 — foodstuffs and animal fodder,
2 — solid mineral fuels,
3 — petroleum products,
4 — ores and metal waste,
5 — metal products,
6 — crude and manufactured minerals, building materials,
7 — fertilisers,
8 — chemicals,
9 — machinery, transport equipment, manufactured and miscellaneous articles.

Note: Total include goods' transport by road, rail and inland water navigation only. Data for Sea and Aviation transport is not available.

Source: Eurostat (Transport); excludes aviation and sea shipping.
* Aggregate covers the following countries BE, DK, DE, ES, FR, IT, LU, NL, AT and PT
** 2002 data.

Table 4.2 Transport related CO_2 emissions for Austrian and imported produce

Fruit or Vegetables	Location grown	Transport mode	g CO_2/kg
Apples	South Africa	Sea and road	263.1
	Austria	Road	22.6
Strawberries	Spain	Road	264.4
	Austria	Road	6.9
Grapes	Chile	Air and road	7410.8
	Austria	Road	8.8
Tomatoes	The Netherlands	Road	104.7
	Austria	Road	0.7
Peppers	Israel	Sea and road	85.4
	Austria	Road	11.3

Note: In spite of big differences in CO_2 emissions the influence on the price might be marginal. The cost of tomatoes from the Netherlands will be one fourth of a euro cent more expecive per kilogramme than the ones from Austria when using a carbon price of EUR 25 per tonne CO_2.

Source: Saunders & Hayes, 2007.

carrots and apples), CO_2 emissions were lower for the conventional system (supermarket) than for the local food system (farm gate to consumer). The key driver of this difference is the transport element. The larger trucks with higher load factors generate lower emissions for the conventionally sourced produce. However, the difference between these two supply systems is still relatively small.

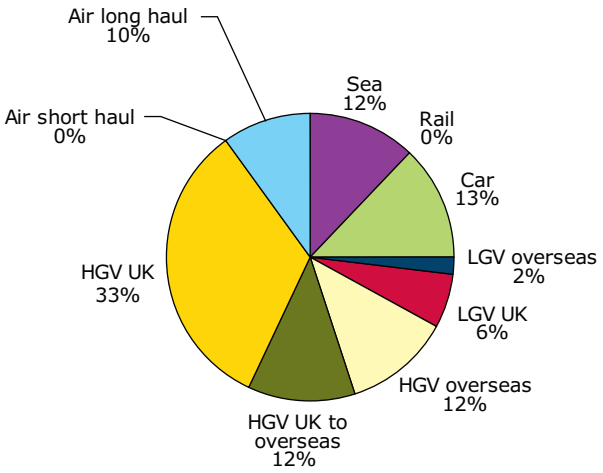
Another study carried out in the US (Pirog *et al*., 2001) demonstrated that locally produced foodstuff has a smaller carbon footprint due to shorter transportation requirements (fewer food-kilometres). At the same time, however, the scientists caution that although food transported in local and regional food systems may travel fewer kilometres and use less fossil fuel to reach the consumer, one cannot assume that these systems are more energy efficient than the food system including long distant transportation.

Figure 4.1 below shows the distribution of CO_2 emissions associated with UK food transport mode in 2002 (DEFRA, 2006b), which shows that air food freight (short haul) emissions are less than 1 % of total food transport emissions in the country. However, the long haul air emissions of CO_2 in the United Kingdom amount to 10 %, of all food transport CO_2 emissions, having in mind that a very small amount of food products are transported by air.

It is difficult to generalise the impacts of food transportation from production locations to consumption due to products coming from different sources and travelling different distances. Research found significant differences across the different types of transport and for different distances travelled (Saunders & Hayes, 2007). Average figures demonstrated that the most efficient short haul freight method is bulk transport by sea vessels (29.77 g CO_2 per kg); however only some food products can be readily transported in bulk and this mode is not available across and within all EU member states. A summary of CO_2 emissions by freight transport mode is provided in Table 4.3.

The second leg of the 'farm to fork' process is related to consumer behaviour or shopping habits. Literature suggests that the environmental impacts of car-based shopping are greater than those of transport caused

Figure 4.1 Distribution of CO_2 emissions associated with UK food transport (2002)



Source: DEFRA, 2006b.

Table 4.3 CO_2 emission associated with different freight transport modes related to food transportation

Short distance (400 km)	g CO_2/kg	Continental transport	g CO_2/kg	Intercontinental transport	g CO_2/kg
Truck	54.66	Truck	204.98	Freight aircraft	8509.68
Electric freight train	69.15	Electric freight train	259.32	Sea vessel	
Inland vessel		Freight aircraft	2149.20	Bulk	2399.29
Bulk	29.77	Sea vessel		Non-bulk	6423.90
On-bulk	79.72	Bulk	599.82		
		Non-bulk	1605.98		

Note: Significant differences were found across the different types of transport and for different distances. The calculations are based on averages from a variety of different sources and emphasise that large differences can occur when different load factors and flights with intermediate landings are assumed in food transportation. This analysis also excludes the transport to and from the loading points.

Source: Saunders & Hayes, 2007.

by the distribution system itself (Foster *et al.*, 2006). The choice of transport mode for consumers, such as walking, cycling, driving or combining the trip with other activities, makes a large difference in terms of the energy and CO_2 emissions associated with food. The impact on the environment of different transportation modes used in fetching food from shops, supermarkets and country markets depends on the transportation mode. The actual effect can vary from 0 g CO_2/trip (as per food and bicycle) to the amounts of CO_2 presented in the study of Foster *et al.* (2006) (see Table 4.4). An important issue is how the impact of the car is allocated to the food purchased. In other words whether it is assumed that the car was used solely to purchase and transport the food, and how many kilograms of food are purchased in the shopping trip. The authors calculate that on a single 5 km trip to purchase 25 kg of food on a journey that is combined with other activities, the purchases will incur an impact of 100.87 g CO_2/kg of food.

Car transport by the final consumer under average circumstances was calculated to use between two to five times as much energy per item as commercial freight transport (Browne *et al.*, 2005).

4.1.1 How it affects transport demand

Food has to find its way from farms to distribution centres. The key factors in transport demand to shops and supermarkets are economic, cultural and social as well as geographic due to the spatial distribution of final consumers. Environmental considerations linked with processing of food such as canning were not analyzed.

Consumer demand of food products is influenced by different factors ranging from types of products to the most significant factors, which is price. The factors and their importance expressed by a percentage of respondents in a study conducted by Institute of Grocery Distribution (IGD, the United Kingdom), a charity comprised of experts from the food industry that drives sustainable improvements in the supply chain, are presented in Figure 4.2.

Consumers in more developed countries can afford food from more distant locations and fresher food compared with processed food. Fresh food requires faster transport and therefore is more energy consuming, whereas processed foods, even from further distances, can be delivered by more environmentally friendly transport modes such as sea or rail freight. New technologies enabling temperature control allows for a wide variety of 'fresh' food to be transported by 'slow modes' of transportation. Though refrigeration and other technologies have additional impact on the CO_2 emissions of both waterborne and land food freight, the share of which is to be assessed. The ***price of food relative to income is the key factor*** in consumer choices for foodstuff (see Figure 4.2), though other factors also play a significant role.

Availability of information on the source of production of food products can influence consumer choice. Other possible information on the carbon footprint (e.g. food kilometres or product's carbon footprint) can also help the consumer to make a decision based on factors other than price.

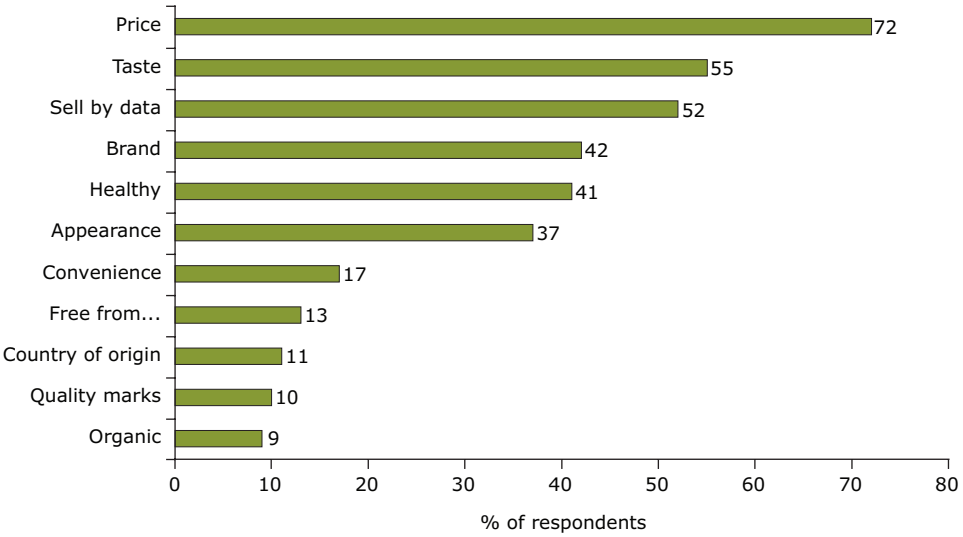
Table 4.4 CO_2 emissions by transport mode and transport distance aimed at food purchase

Transport mode and transport distance	g CO_2/trip
Consumer on foot	0
Consumer on bicycle	0
Consumer by car, specifically for shopping	
5 km single trip	4034.87
10 km single trip	8069.73
15 km single trip	12104.60
Consumer by car, combining shopping with other activities	
5 km single trip	2521.79
10 km single trip	5043.58
15 single	7565.38

Note: It is assumed that 25 kg of food is purchased per trip.

Source: Foster *et al.*, 2006.

Figure 4.2 What drives consumer choice?



Source: IGD, 2005.

Demand for fresh fruits and vegetables could increase the use of fast freight transport (e.g. air freight) and, conversely, consumption of canned or preserved out of season fruits and vegetables will reduce the impact on transportation and its urgency due to longevity of the produce form.

The distance of transportation of food products also has an impact on the type of transport mode used. Fresh fruit and vegetables travelling from overseas will likely be shipped by air, while canned fruits and vegetable may be transported by sea freight. There are examples of oranges and grapefruits being flown to Europe from Florida, for example. Other fruits are shipped to Europe from distant parts of the world such as bananas from the Caribbean and Africa; apples from New Zealand; pears from US and Chile; grapes from Chile, Brazil and Argentina; oranges from Brazil and US and avocados from Mexico and South Africa.

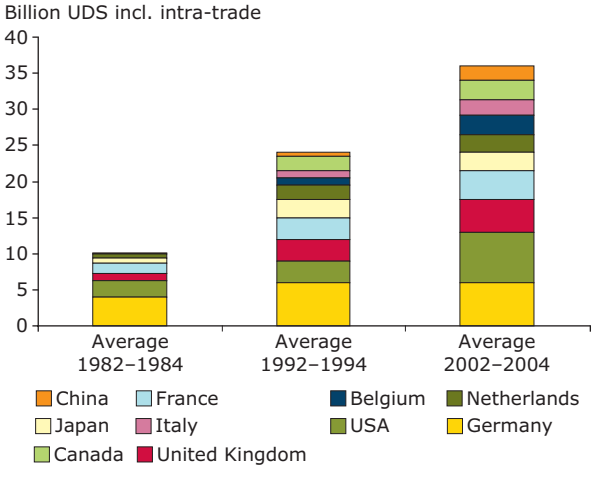
On the European scale, countries located more remotely from the production areas of certain products (e.g. tomatoes) will spend more on transportation whilst countries reliant on local produce will spend less. Food from closer locations is mostly transported by road, while food transportation over longer distances can be by sea, rail and road transport depending on the foodstuff longevity and degree of processing.

4.1.2 Recent trends

Transportation of fresh fruit and vegetables on a global scale increased several times between 1982 and 2002 (see Figure 4.3).

An AEA Technology report (2005) notes that between 1992 and 2002, urban food kilometres increased by 27 %, HGV food tonne kilometres increased by 36 %, and air freight increased by 140 % in the United Kingdom. This increasing amount of food transport has led to a 12 % increase in the CO_2 emissions associated with food.

Figure 4.3 World fruit and vegetable importers



Source: Saunders and Hayes, 2007.

Improvement in load factors and larger HGVs has helped offset the increase in HGV tonne kilometres, but the authors highlight that the trend in improved utilisation may occur for only a finite period, after which there may be more significant increases in food vehicle kilometres.

In some countries, such as the United Kingdom, reliance on local produce is decreasing. It is estimated that the United Kingdom's self-sufficiency in fruit is 9 % (organic fruit — 6.6 %) and in vegetables — 62 % (organic vegetables —64 %) (Garnett, 2006). At the same time the diversity of grown products is decreasing, which increases the food stuff transportation demand (Pirog *et al.*, 2001). The later study states that the number of commodities produced for sale on at least 1 % of all Iowa farms for selected years from 1920 to 1997 has decreased from 34 to 10.

It has also been found that food (including drink) has the longest average length of haul compared to other goods; over the last ten years it has remained fairly constant at just over 120 km (road freight) (Garnett, 2006).

The load factor, which is the ratio of goods moved (tonne kilometres) to the maximum tonne kilometres achievable, if the vehicle is loaded to its maximum capacity, fell from 63 % in 1995 to 57 % in 2005. This decrease reflects changes in the mix of goods towards less dense but bulkier commodities such as food, and the increased capacity of the vehicle fleet as more, larger vehicles are used. Additionally, the packaging requirements and bulkier packaging, especially for food products, may have contributed to this factor.

Food transportation by air currently represents a very small proportion of food consumed. However, aviation-related transport emissions are likely to become more significant in the future, taking into account the rapid growth rate of this mode and the non-CO_2 impacts of aviation emissions on climate change (Tyndall Centre, 2001).

The increase in urban food kilometres has been influenced by increasing car ownership and changing shopping patterns (willingness to travel further to shop for food), especially with the development of out-of-town supermarkets.

4.1.3 Interactions with other sectors

Food consumption is related to other sectors in many ways. Agricultural practices determine how, when and where the primary ingredients are produced. Industry then processes these ingredients into products, which then pass through wholesale chains and retail outlets. Finally, the domestic sector determines how they are transported and stored before final consumption.

Agricultural practices and geographic distribution of foodstuff sources

Globalisation and the increasing economic integration of EU member states have led to considerable growth in the demand for food products and produce from different countries. The products being transported by freight transport range from live animals, vegetables and fruits, milk and milk products, canned products, to beer and water. The territory of the EU includes several highly industrialized and densely populated areas, which generate considerable demand for raw materials, final food products and foodstuffs. Many of the materials from overseas (even within the EU) are imported by sea (by volume and weight); in connection with their transhipment in European seaports (like Rotterdam, Marseille or Hamburg), they have to be carried to their final destinations within the countries or further within Europe by road or rail (Eurostat, 2007). Refrigeration on the route to the destinations requires additional energy.

Examples of live animal trade are pigs from the Netherlands to Spain, sheep from Romania and Hungary to Greece, and cattle from Ireland to Italy, most of which happen by road freight (Stevenson, 2008). Transportation of live animals for meat is driven by the demand for fresh meat in some countries and cultural preferences.

In the production cycle of certain food products, e.g. fruits and vegetables, it may be more economical and environmentally friendly to transport them from a warm climate than to grow them in Northern or Central Europe. A report by AEA Technology (2005) shows that it may be less environmentally friendly to grow British tomatoes than it is to import tomatoes from Spain. Significantly more energy is needed to heat the glass houses for growing tomatoes in Britain than to transport tomatoes from Spain, where no heating is used because of the warmer climate. However, processed produce versus fresh produce can be a seasonal winner and solution in the countries where those products cannot be produced locally.

Western Europeans are the world's largest bottled water consumers (85 litres per person per year) (Ferrier, 2001). On a per capita basis Italy consumes nearly twice as much of bottled water as the US followed by others such as the United Arab Emirates, Mexico and France. The average world

consumption grows by 7 % each year. Bottle water consumption reflects a certain life style, which has long traditions in Europe (since early XIX c.). Bottled water is in most cases an alternative to tap water, however in many public food and drinking places tap water is no longer made readily available. A major contributor to the cost of bottled water is likely to be transport, certainly where transport is international. Over 22 million tonnes of the bottled liquid is transferred each year from country to country (CIWEM, 2008).

Food processing industry

Food cycle interaction with industry is very complex. It involves the positioning of food processing plants (closer to the fresh food ingredient supplies or closer to the consumer), and processing these ingredients into products, which then pass through the wholesale chains and retail outlets. The elements of this process with significant transport demand are supply of packaging material and different foodstuff ingredients. The Wuppertal Institute published a report about the transport activity associated with producing yoghurt sold in Germany (Böge, 1995), which demonstrated complex footpaths of the product ingredients (see more in the Box 1).

Food processing drives seasonal, or attracts permanent, labour migration, which then leads to the need for these workers to travel to work places. In the United Kingdom businesses such as packhouses and other first stage processors, e.g. meat and fish processors, which supply the retail sector with much of our fresh food, rely to a significant extent on a labour force supplied by temporary labour providers (DEFRA, 2006).

Food retail sectors

Big supermarket chains dominate the food retail sector. Over 70 % of UK groceries are sold by four supermarket chains – Tesco, Sainsbury's, Asda and Morissons, (source www.agrifoodstrandards.net). Europe's food top 5 retailers are Carrefour, Metro, Tesco, Rewe and Auchan (source www.extendedretail.com/). Supermarket chains are able to better manage the food transport from a logistical point of view and can achieve lower transportation costs per food kilometre, while smaller suppliers cannot provide the same efficiency.

Local food supplier chains are being created in Europe on national, regional and international level, however they have little interaction with international food retail giants (Holt, 2007). Some locally growth products are marketed as organic or locally known brand names.

Actions of retailers on raising awareness on food kilometres and international trade of food products are the labelling, which enables the buyers to see the country of origin of the product as well as in some cases the emphasis of the local produce and products on the shelves of the shops, though such marking of the origin of the products is not required for all produce and products by regulations.

4.1.4 Influencing factors

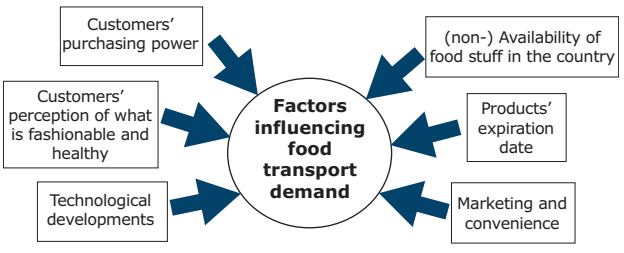
The impacts of food transport are complex and involve many trade-offs between different factors. The key factors identified in the literature are presented in Figure 4.4.

As ***people get wealthier,*** there is a tendency to consume more calories and high value-added products, such as meat. Culturally, the food we eat is partly determined by what is perceived to be ***fashionable, or healthy.*** Social norms, such as dining out or eating 'on the go', also have a large effect on how we consume food.

Technological developments, such as the advancement of refrigeration technology allow us to enjoy fresh fruits and vegetables from other parts of the world. Products' ***expiration*** drives the demand for faster freight transport modes such as road and air. Preserved and long lasting food products can be shipped by rail or inland waters. The ***Availability*** of food in the country and the demand for certain products drives the import of food products and air freighting of food. For example, tomatoes from Spain may be preferred to local tomatoes. However this preference may be influenced by price, local tomatoes can be more expensive due to costs related to growing conditions.

Marketing and convenience, bottled drinking water marketing has driven the food and drink outlets to banish the tap water from the menus and offer

Figure 4.4 Key factors influencing food related transport

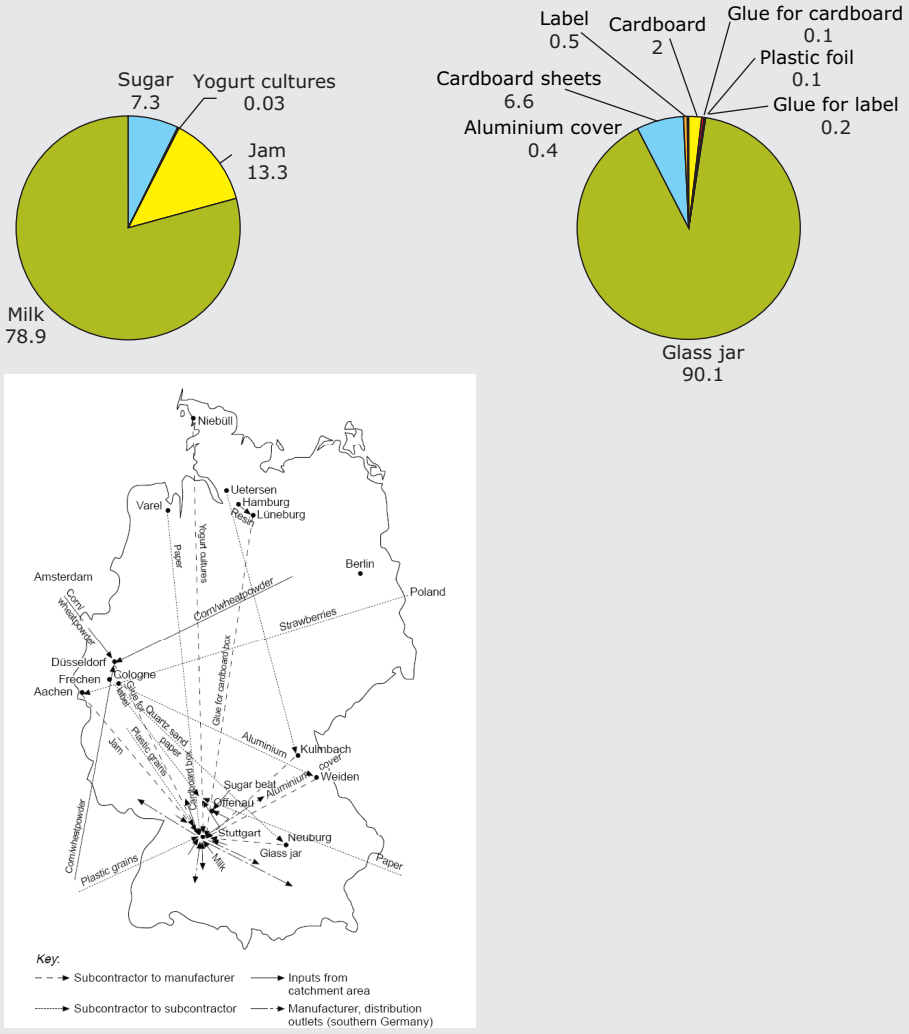


Box 1 A case study of well-travelled yogurt pot

Product-related research (Boge, 1995) revealed the importance of distance in the system of production, distribution and consumption based on the example of a yogurt pot. It demonstrated the complicated path and differing travel demand for ingredients that may be used in the production of one product. It also details the different footpaths and carbon footprints of ingredients from production to consumer. This showed that a small glass jar of strawberry yoghurt for sale in Stuttgart required the following inputs:

- strawberries transported from Poland to west Germany for processing into jam and then transported to southern Germany;
- yoghurt cultures transported from north Germany;
- corn and wheat flour transported from the Netherlands;
- sugar beet transported from east Germany;
- the labels and aluminium covers for the jars transported 300 km whilst;
- only the glass jar and the milk were produced locally.

Figure 4.5 Yogurt transportation relations



Source: Stefanie Böge, 1995.

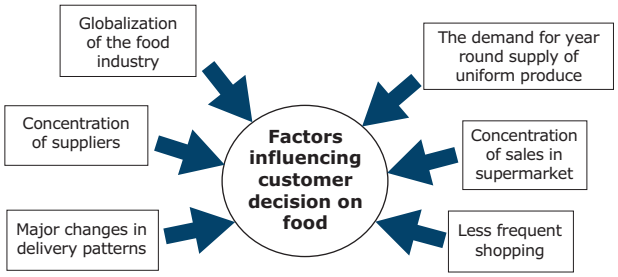
The research concluded that in order to bring one truckload of product to a distribution outlet in southern Germany, one 'theoretical' truck (including all examined relationships) must be moved 1 055 km. In 1992, theoretically, 24 fully packed lorries with 150 g stawberry yogurt pots had to be moved to produce one jar of the product.

bottled water instead. It is perceived that bottled water may be safer to drink than local municipal water.

Key factors influencing the final customer decisions with respect to travel to specific food outlets, the frequency of travel on private shopping trips, and the choice of the distance have been identified by the UK Department of Environment, Food and Rural Affairs (AEA Technology, 2005) and are detailed in Figure 4.6 below.

Food transport emissions from air freight are likely to become more significant in the future if no restrictions or measures are introduced. The proportion of fresh produce air freighted will be influenced by four main factors (Foster *et al.*, 2006);

Figure 4.6 Factors influencing final customer food shopping decision



Note: *Based on AEA Technology*, 2005

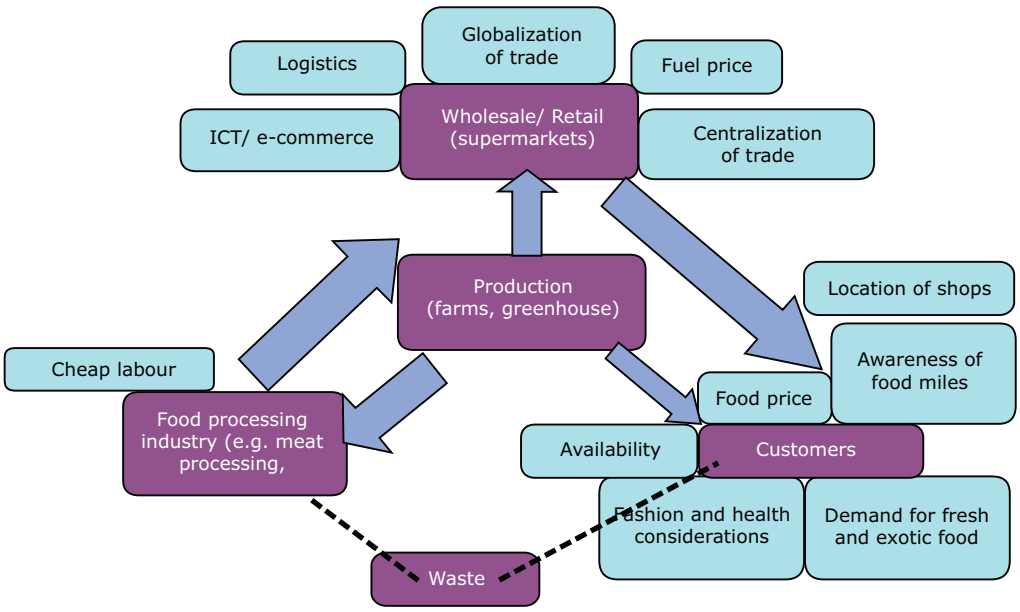
- The types of produce demanded will affect the quantity air freighted. For example, an increase in the demand for perishable produce such as vegetables will require additional air freight whilst an increase in less perishable foods such as bananas or apples will require less air freight.
- Costs for air and other freight transport.
- Changes in produce specification requirements such as added value (e.g. peeled or as ready to go salad) may increase air freight requirements.
- The effects of country of origin or air freight labelling on consumer buying behaviour.

The full set of factors influencing food transport demand can be analysed through a Life Cycle Analysis (LCA), which is the tool often used to assess food production and consumption effects. Additional factors which could be analysed are related to food waste and food processing waste. They are worth mentioning since there are many related policy measures developed that have not been discussed in this study. A summary of food transport factors discussed in this case-study is provided in Figure 4.7 below.

4.1.5 Possible actions by actor

The key actors in the food life-cycle are ***producers, wholesalers/retailers,*** the ***processing industry, importers/exporters, consumers*** and ***governments.*** The ***European Community*** can, however, also make a useful contribution in this area by initiating and partly supporting measures that provide

Figure 4.7 Summary of food transport factors



information on food sector transport effects on the environment, as well as reviewing the existing measures relating to the production and consumption of food produce. They can also locate opportunities for reducing transport effects of food production on a European an d global scale.

Sustainable food production and consumption is a wide concept which incorporates sustainable agriculture, processing, transportation and consumption. Food transportation is just one, albeit an important part of it, which can be tackled only by mapping perceptions of 'sustainable food production', identifying objectives and solutions and linking these to cultural differences and consumption patterns. Several measures have been already devised, which could be developed further to create a bigger impact and reduce the negative impact of transport on the environment in the food cycle.

Produces and retailers

The debate on food and food kilometres has been going on already for some time. It has served to highlight the importance of the issue of climate change in the behaviour and attitudes of consumers and politicians, and the growing importance of reducing greenhouse gas emissions. The issue of food-kilometres (and air-kilometres in food trade) has led to an increased demand for ***food labelling*** to show its impact on greenhouse gas emissions. In the United Kingdom, the Carbon Trust, an independent body whose aim is to help companies reduce their carbon emissions, is launching a trial carbon labelling scheme (www.carbontrust.co.uk). The Soil Association, a leading United Kingdom organic certifier, is currently contemplating removing the eligibility of air freighted fresh produce to be labelled organic (Saunders & Hayes, 2007). In March 2008, Trans Atlantic Consumer Dialogue called for US and EU governments to make country of origin labelling (COOL) a mandatory programme (TACD, 2008).

Efforts are already made by some member states to provide ***consumer information*** regarding the source of various food products (Carbon Trust, 2008). However, such practices are still not mandatory under EU regulations (EC, 2008). Consumer information on product carbon footprints (food-kilometres or overall greenhouse gas emissions) can influence the consumers' food choice and prompt the buying foodstuffs with fewer food-kilometres or less greenhouse gas emissions, even at a higher price.

In order to reduce the environmental footpath of any particular food product, manufacturers have three basic options for production (Böge, 1995):

- use inputs from nearer subcontractors;
- improve existing transportation vehicles; or
- shift to more environmentally sound freight shipment vehicles.

In order to reduce emissions from foodtransportation ***retailers*** could:

- encourage local food consumption by providing information on the product kilometres and transportation & production energy of the products;
- promote local brands;
- promote local producers (e.g. bottled water from local supplier and producer);
- market seasonal products;
- use less packaging and charge for single use plastic bags;
- develop smart logistics; and
- actively supporting government interventions to reduce market barriers to sustainable behaviour.

Consumers

Consumers must be encouraged to take ***fewer shopping tips*** or ***combine journeys*** to reduce shopping journeys. ***Walking and cycling*** to food retail centres must be encouraged. Governments around Europe are developing strategies and guidelines on walking and cycling as alternatives ways of transport for local journeys (e.g. Belgium, France, Luxemburg, and the United Kingdom).

Consumer choices are very hard to influence, however shifting consumers e.g. from bottle still water to tap water would have a huge impact on the environment and potential for reduction of greenhouse gas emissions. The US Conference of Mayors in June 2008 decided to act by showing an example and passed a resolution calling for a phasing out of bottled water by municipalities and promotion of the importance of public water supplies (http://www.usmayors.org). International transportation of bottled water could be ameliorated somewhat if international brands were to licence local supplies to be bottled under their names (CIWEM, 2008). Consumers could be encouraged to make choices which can make a difference in reducing food-kilometres. Such choices are:

- eating locally produced food products;
- going shopping by sustainable transportation modes (walking, cycling or public transport);

- shopping locally and not travelling to distant shopping centres;
- buying seasonal produce or out of season canned products;
- reducing number food shopping trips; and
- buying products with fewer food kilometres or travelled by slower mode (e.g. shipping or rail versus air).

Raising global energy prices will inevitably have impact on the transportation costs and final costs of food to the consumer, which will have direct impact on the consumer choices.

Local and national governments

With shopping centres moving from city centres to remote edges of towns and cities (trend observed in some EU-12 countries), ***spatial planning policies*** need to be set appropriately to facilitate the change for more convenient and shorter food shopping patterns. UK Planning Policy Guidance 13 (Transport) states that 'land use planning has a key role in delivering the Governments integrated transport strategy. By shaping the pattern of development and influencing the location, scale, density, design and mix of land uses, planning can help to reduce the need to travel, reduce the length of journeys and make it safer and easier for people to access jobs, shopping, leisure facilities and services by public transport, walking, and cycling.' The Guidance also states that 'reducing the amount of parking in new development is essential… to promote sustainable travel choices' (Paragraph 49).

Other possible actions for governments and local governments include ***supporting local producers and promoting and supporting carbon footprint labelling***.

European Community

The ***European Union*** may further influence food consumption through harmonised ***carbon based taxation*** covering the transport sector. The lack of tax on aviation fuel has been argued as in effect subsidising highly energy-intensive air freight transport. The absence of tax on aviation fuel is in contrast to most other freight transport modes which are dependent on highly taxed petrol and diesel.

In 2002 EC has issued ***Packaging and Packaging Waste Directive 94/62/EC,*** aiming to prevent or reduce the impact of packaging and packaging waste on the environment and contains provisions on the prevention of packaging waste, on the re-use of packaging and on the recovery and recycling of packaging waste. In the 2006 report on the implementation of the Directive, the EC promised to look into the issue of packaging of consumer beverages, which have been roughly estimated account to 20 % of total packaging by weight (EC, 2006c).

The ***European Parliament*** has recently passed a resolution that calls for 'the introduction of WTO- compatible common standards and labelling schemes regarding the GHG implications of different products, including at the production and transport stages'; 'a procedure to assess and label these ecological footprints and to develop software in order to enable businesses to calculate the quantity of GHG emitted from every production process'; and 'the development of a scheme based on sound life-cycle data which includes finished goods, such as cars and electronic equipment' (European Parliament, 2007).

Other actions that could be linked with stricter regulations regarding the empty running of freight vehicles used for transportation of goods and food stuff and production and supply sections of the food life cycle, however this these issues are not straightforward and will need more research to offer solutions.

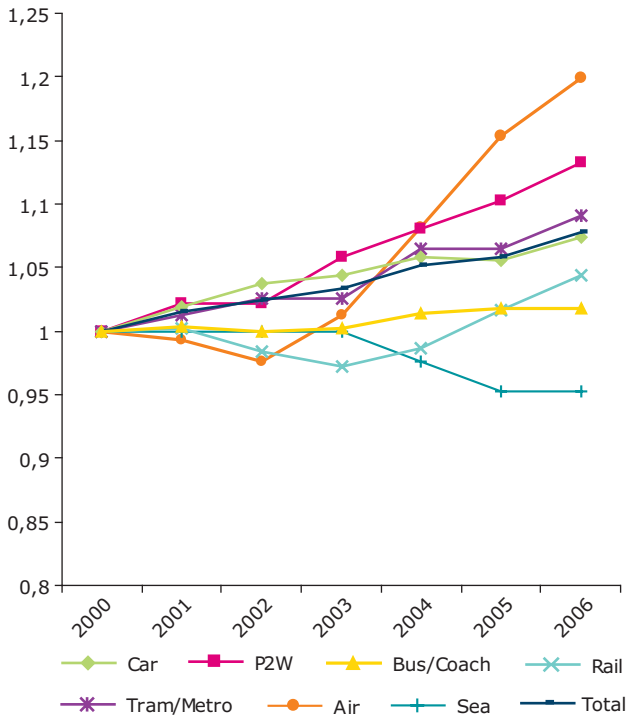
4.2 The increasing use of short-haul air travel for business and leisure travel

Aviation is the fastest growing mode of transport in Europe, both in terms of passenger volume and as a source of greenhouse gas emissions. According to Eurocontrol (2008), air transport volume in the ESRA area ([10]) grew by roughly 75 % between 1990 and 2005. Intra-European flights (including domestic and to non-EU countries) account for roughly 75 % of EU air passengers (Eurostat, 2004).

The spread of air travel has drastically changed the way in which Europeans conduct business, visit family and friends, and spend their holidays. These changes have at least in part been driven by, and in turn support, the enlargement and further integration of the European Union, the free movement of people, the creation of a single labour market, and free competition.

([10]) ESRA refers to the Eurocontrol Statistical Reference Area, and includes the following countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, FYROM, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Moldova, Netherlands, Norway, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

Figure 4.8 Changes in passenger transport demand in EU-27 since 2000



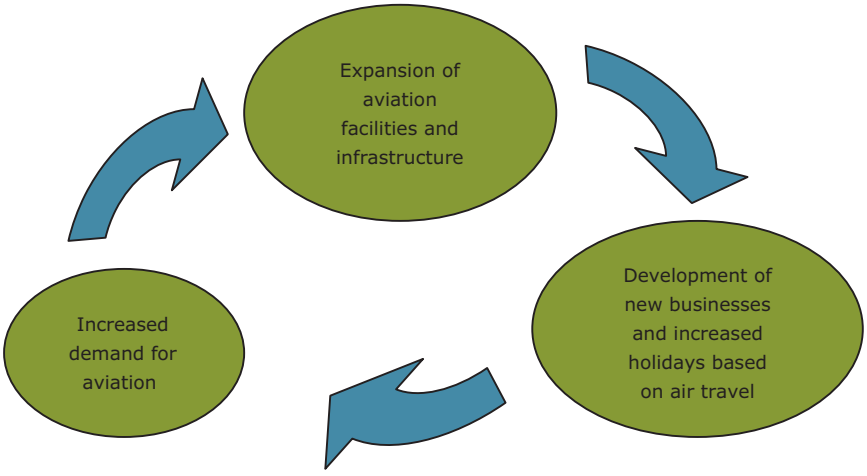
Source: EC, 2007e.

On the other hand, air travel negatively affects the local and global environment in many ways. Air pollution, noise and vibration are of large concern, particularly near airports. With respect to climate change, there is a growing body of evidence that emissions from aircraft have larger impacts on climate change compared to emissions from land-based transport (see IPCC, 1999). This is due to the fact that aviation emissions are released in the upper troposphere, where gases other than CO_2, such as oxides of nitrogen (NO_X) and water vapour create extra greenhouse effects.

4.2.1 How short-haul air travel affects transport demand

The growth in aviation demand is attributable to developments in a few different sectors, including business and tourism, which will be the focus of this section. As described in the Chapter 1, it is inherently difficult to separate developments in a sector external to the transport sector against those within it, because of the mutually enforcing interactions between the sectors. The case of air travel for business and leisure travel is exemplary to this effect, as will be shown below.

Figure 4.9 A potential cycle of increasing air travel dependence



In the business sector, offices and whole business estates are developed around airports to benefit from the increased physical accessibility to various regions in Europe and beyond. Airports themselves are not only seen as transport hubs, but as retail centres, conference/meeting venues and even accommodation facilities. As Van Wijk (2008) points out that some airports such as Schiphol (the Netherlands) have developed into cities in their own right.

The increased use of aviation for leisure trips is witnessed in some countries by the popularity of 'city breaks' over the weekend, stag/hen parties in Eastern European capitals, and workers flying back to meet parents over holiday seasons. The whole tourism sector, including travel agents, hotels and tourist authorities are adapting quickly to the new levels of air transport.

As air travel becomes the preferred mode of travel for leisure and business, pressure is placed on local and national governments to supply necessary infrastructure in the form of airports, extra runways and access roads. Expansion is often argued as being necessary to avoid airport congestion, and to enable economic competition with other regions and/or countries.

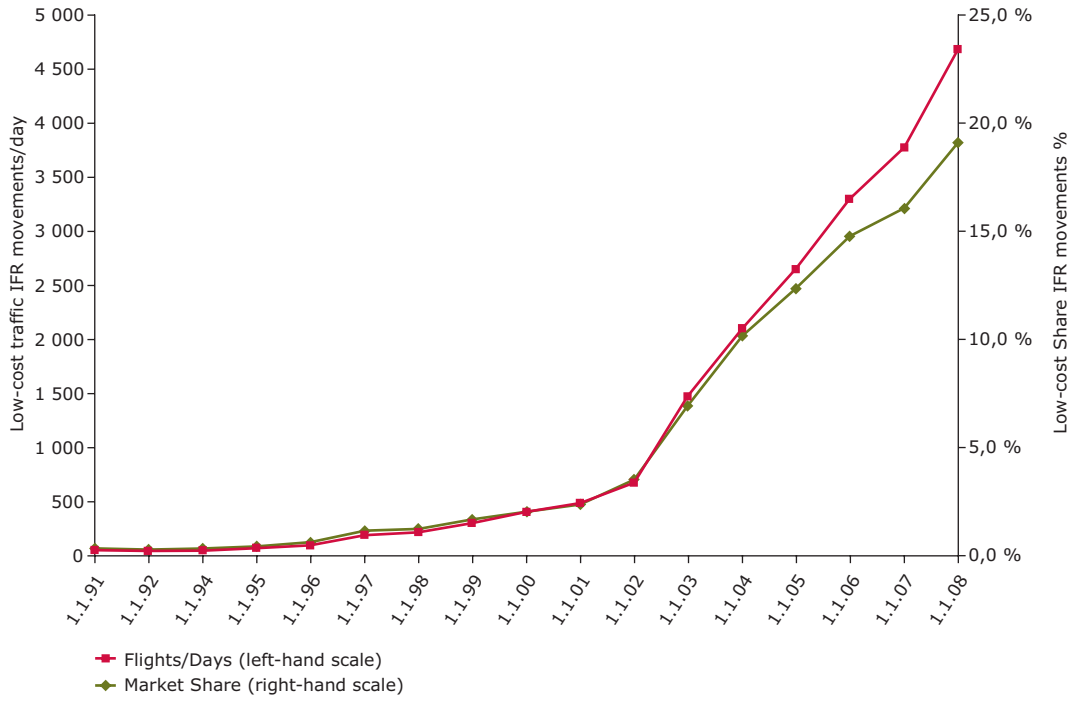
Cairns and Newson (2006) illustrate an analogy of the growing supply of aviation infrastructure to road building, whereby new roads are created to accommodate increasing traffic demand. As new road space becomes available, extra traffic is generated and congestion worsens. There is a potential for the same phenomenon to occur with air traffic, whereby the demand for air travel grows in line with growth in supply.

A self-enforcing cycle is hereby created, where developments outside of the aviation sector induces changes within it, allowing for further changes in the outside sectors.

4.2.2 Recent trends

Air transport continues to expand globally. According to the Airport Council International (ACI, 2008), the industry achieved a growth rate of 5.6 % in passenger traffic in 2007. The International Air Transport Association (IATA, 2007) predicts a further 600 to 700 million new passengers in the next five years. Although growth is predicted to be strongest in Asia, the second biggest expansion is expected in Europe (approximately 150 million

Figure 4.10 Growth of low cost airlines in Europe



Source: Eurocontrol, 2007.

passengers between 2006 and 2011). Much of this is expected to be in the short-haul market.

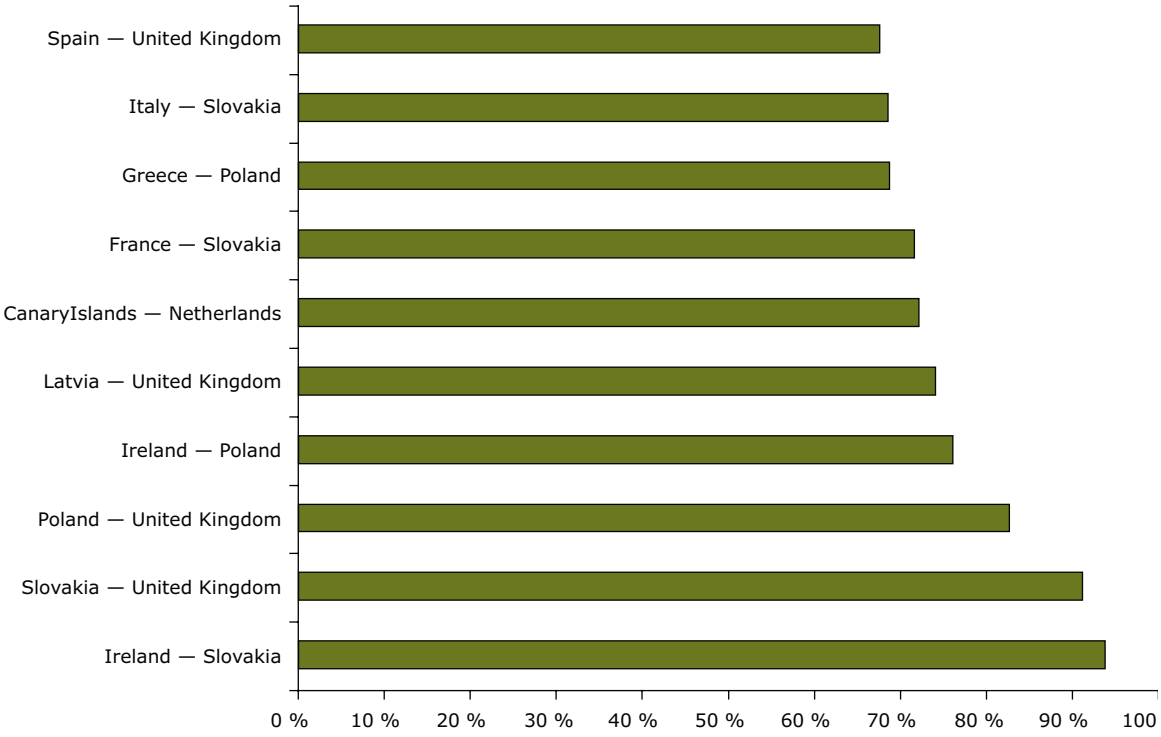
The growth of the aviation sector in Europe has in large part been driven by the rise of low-cost airlines, following the deregulation of the market in the 1990s. This has more than offset the decrease in the growth rate of passengers carried by the traditional or established carriers which used to dominate the market.

The low cost carriers are served by regional airports which typically offer lower landing charges. This has made air transport more accessible and convenient for local populations who no longer need to travel to the major airports to access international (largely European) flights. The emergence of low-cost carriers has placed a downwards pressure on the ticket prices of traditional airlines as well. For example, Aer Lingus (who were in direct competition with Ryan air) were forced to radically redesign their business model to compete (Barret, 2006).

According to the Economist (2008), 1 000 new 'city pairs' were added to European airline schedules between 2003 and 2007 (Economist, 2008). Many new routes have been established to link the countries in Western Europe (most notably the United Kingdom and Ireland) with those in Central and Eastern Europe. For example, there are now 27 scheduled routes between Britain and Poland, up from a mere five in 2000 (CAA, in the Economist, 2008). Most of these routes are served by low-cost carriers, as shown in Figure 4.11.

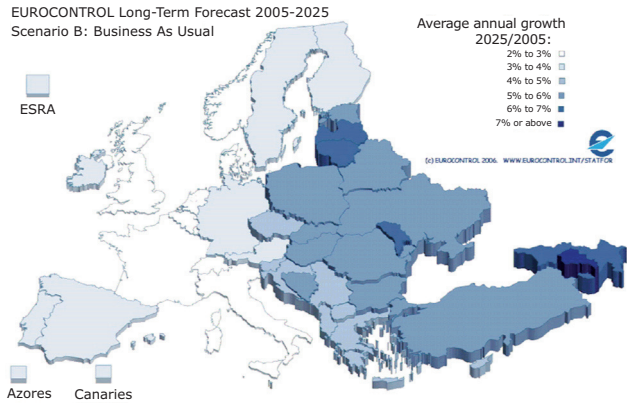
Currently, the absolute growth in air traffic is strongest in Western European countries, such as Spain, Italy, Germany and the United Kingdom. However, the rate of growth is highest in the Central and Eastern European countries. This is particularly true of Romania, which has experienced high rates of growth after joining the European Union. According to Eurocontrol (2006a), this rate of growth is expected to continue for the foreseeable future, although the last few months have seen some routes close as a result of the increases in fuel prices and weakening economy.

Figure 4.11 East-West connections with large shares of low-cost flights



Source: Eurocontrol, 2007.

Figure 4.12 Forecast of the annual air traffic growth till 2025



Source: Eurocontrol, 2006a/07.

4.2.3 *Interactions with other sectors*

The increase in air travel is influenced by developments in other sectors, and in turn affects different external sectors. Examples of such interactions are limitless; however here we highlight the tourism and business sectors and their relationship with air transport demand.

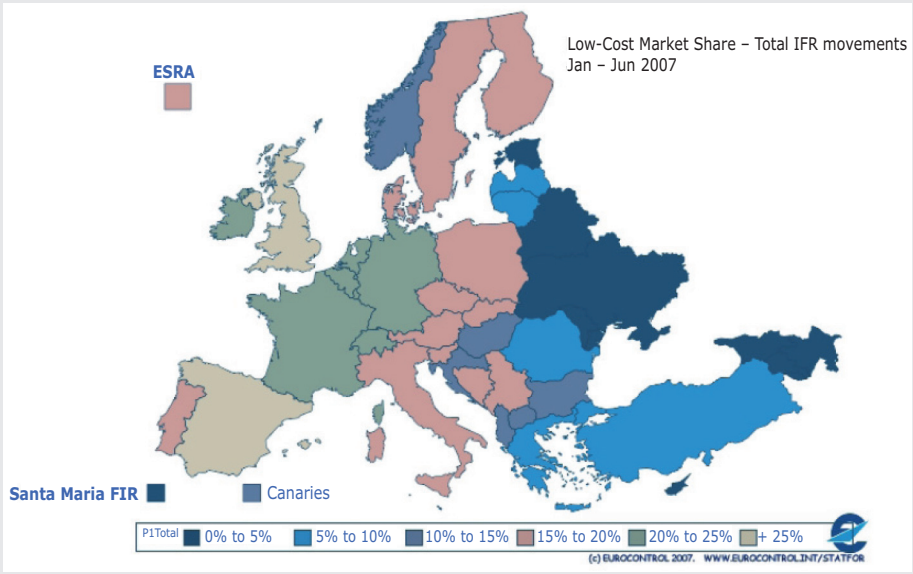
Air travel and the tourism sector

According to WTTC (2006) in EEA (2007), tourism generates 3.37 % of total employment, and 3.78 % of GDP at the pan-European level. In some countries such as Cyprus and Malta, the sector can account for more than 10 % of GDP (EEA, 2007) making it a sensitive topic. Official statistics show that air travel

Box 2 The United Kingdom as a Hub for low cost carriers

The United Kingdom is a major origin and destination for air travellers in Europe, with a high percentage of low-cost carrier services.

Figure 4.13 The United Kingdom has a large percent of low-cost carriers



Source: Eurocontrol, 2008.

From 1998 to 2007, air traffic in the United Kingdom grew by approximately 60 %. The majority of the United Kingdom's air traffic movements originate from the London airports. However, the largest growth for UK air traffic movements has been seen in routes from regional UK airports to EU destinations as shown in Table 4.5, reflecting the strong growth of the low cost market.

Table 4.5 Total air traffic growth between 1998 and 2007

	Domestic	EU	Other International
London area airports	19.34 %	54.51 %	23.99 %
Other UK airports	52.99 %	98.19 %	48.38 %
Total UK airports	41.65 %	70.72 %	28.05 %

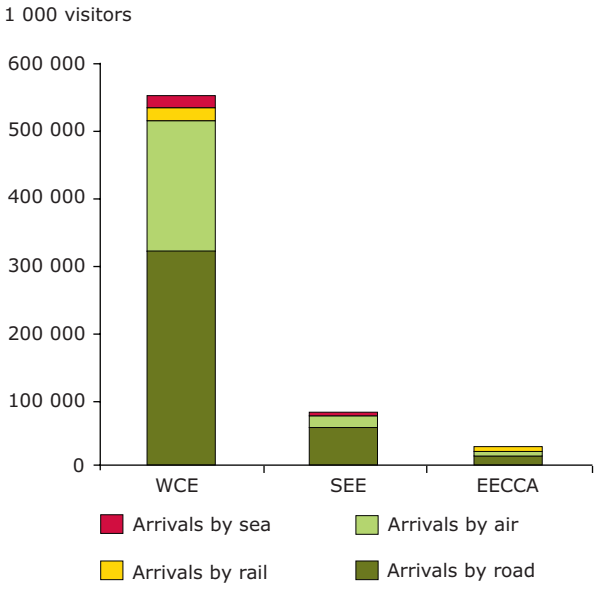
Source: CAA, 2008.

London Stansted and London Luton experienced growth of roughly 400 % and 200 % between 1997 and 2007 respectively (CAA, 2007). These two airports are key hubs for Ryanair and EasyJet, both representative players in the low-cost market. Regional airports have also seen strong growth. For example, Coventry's passenger traffic grew from only 1 520 passengers in 1997 to over 539 441 passengers in 2007. Doncaster Sheffield Airport, which opened in 2005, served 904 515 passengers in 2007 and air traffic at Prestwick Airport has grown by over 600 % in the last ten years. Liverpool experienced double this growth rate between 1997 and 2007 with the arrival of low cost carriers (CAA, 2007).

is a major mode for tourists to European countries, together with road transport.

Stakeholders in the tourism industry, including local and regional governments, increasingly consider aviation as a major factor in ensuring growth of the sector. Tourism strategies of regions across Europe often emphasize the importance of aviation, and the development of airports and other air travel facilities is often subsidised by the local regions.

Figure 4.14 A large proportion of tourists arrive by air



Note: Reference year is 2005 (2004 for some countries).

Source: UNWTO, 2006.

The following Extract from the Lapland Tourism Strategy (2003–2006), Finland illustrates the emphasis on air travel:

'The interests of tourism, commerce and industry require functionality of traffic system and the growth of tourism demand has a crucial position in the improvement of the accessibility of the province. Direct regular flights without intermediate landings have improved the competitive position of Lapland in tourism market. Furthermore, the growth of demand and its division more and more evenly throughout the year have generated new regular air traffic. Regular airline services are supported by charter flights that are flexible in regards to demand. Several airline companies fly to Lapland. Access traffic from airports and railway stations to tourist centres runs smoothly and the road connections between centres are of a high level.'

The will of regional governments to attract airlines can also result in cases of illegal state aid. For example, Ryanair was accused of receiving illegal subsidies in the form of discounted landing fees, office space and training facilities at Charleroi Airport in Wallonia, Belgium. Ryanair was ordered to pay back 4 m Euros to the Wallonian regional government (see BBC, 2004).

Air travel and the business sector

Businesses base their decisions on where to locate partly by the availability and quality of transport links. Organizations are concerned about the level of access to skilled labour, supplies, support services, and markets. Some business sectors rely heavily on aviation for conducting their business, including banking and finance, insurance, printing and publishing (York Aviation, 2004). Airports are therefore seen by many regional bodies, as well as national governments, as a necessary tool to maintain/improve competitiveness, and attract and retain businesses, especially multinationals with a high dependence on air travel.

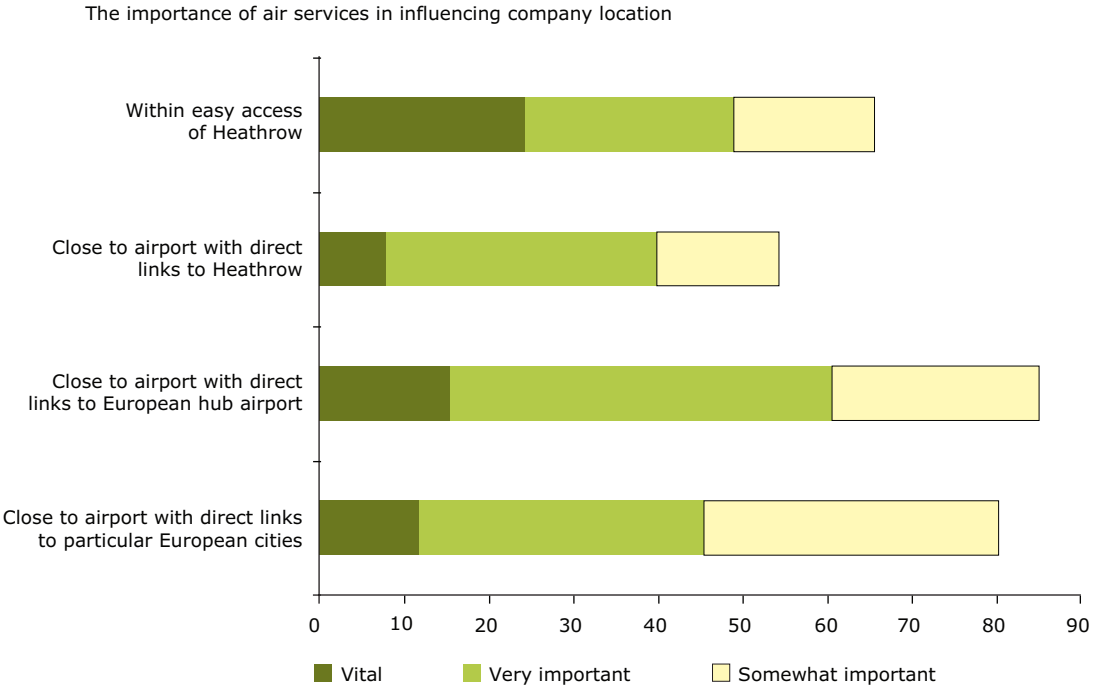
For example, a survey of 165 UK companies by OEF (2006) showed that proximity to an airport with direct links to a European hub airport was considered to be either vital or very important in influencing company location, by roughly 60 % of responding organizations.

The business models of airports themselves have also evolved to include conferencing/meeting facilities, extensive retail activity, parking and catering. Rather than being only a transport terminal, it can be said that an airport is now becoming a destination in its own right. Key examples include Schiphol in the Netherlands and Frankfurt in Germany (see Van Wijk, 2008).

4.2.4 Influencing factors

The pool of empirical research available today suggests a few factors that are of particular importance to understanding the drivers of air transport demand. **Economic factors,** in particular disposable income, air ticket price and price of competing modes (e.g. high-speed rail) are often regarded as key determinants of air traffic demand (see Hanlon, 2007). In addition, **spatial factors** such as the distance to the nearest airport are likely to impact on people's travel decisions. **Social-demographic changes,** such as the increased movement of people across Europe, also have a large effect on air travel. Furthermore, **cultural factors** such as image and status of flying, and environmental consciousness are likely to impact on demand. Marketing also drives people's decision to fly, as it may influence the perceived cost of travelling by air, as well as the image and status of flying described earlier. Although these factors often apply across all air travel users, an attempt is made below to highlight differences in the scope and scale of influence between the two sectors of business and tourism.

Figure 4.15 Business attitudes towards airport access



Source: OEF, 2006.

Economic factors

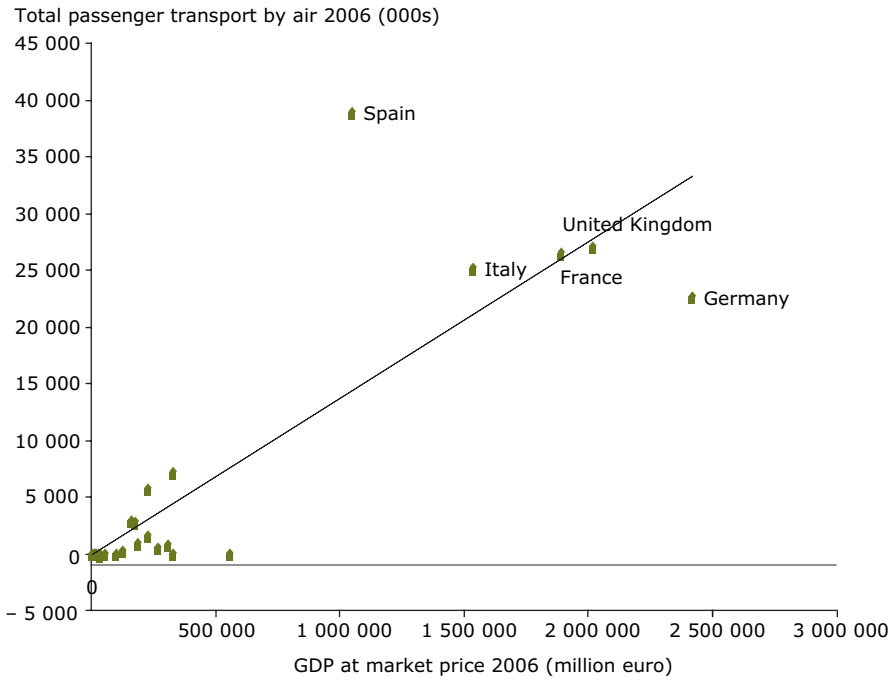
Economic factors such as **income** and ticket **price** are major determinants of air transport demand. As people's incomes grow, their preference towards non-essential travel (e.g. holidays), speed and comfort ([11]) also increase, making aviation an attractive option (see Doganis, 1995). IATA (2008) calculates that for a 1 % rise in income (typically measured in GDP per capita), demand for air travel in developed economies increases by 1.5 % for short haul, and 1.7 % for long haul ([12]). Short haul journeys are arguably less sensitive to changes in income, reflecting on the fact that they are more commoditized compared to longer journeys which are typically made by those with more disposable income (IATA, 2008). Although income and air travel demand are strongly related, there is not necessarily a one-to-one relationship between the two. Cairns and Newson (2006) point out that European countries with comparable levels of aggregate wealth (e.g. France and the United Kingdom) often have very different levels of air passenger demand (see Figure 4.16). This may reflect the availability of substitutes (e.g. the TGV in France) as well as other factors such as ticket price and quality of service and trip attractors such as tourist sites.

The growth in income is likely to put an upwards pressure on demand for air travel, especially with regards to leisure travel. A downturn in the economy with a reduction in income would have the opposite effect, which is currently being observed temporarily as a result of the global economic slowdown.

The price of the flight is another large factor affecting demand. The effect differs by region, journey purpose and length of the flight. IATA (2008) shows that short-haul intra-European flights have a price elasticity of around – 1.2 ([13]).

Gillen *et al.* (2007) suggests from the Canadian context, that on the whole the price elasticity of air travel is higher for leisure travellers compared to business travellers. This is understandable given that business travellers do not carry the costs themselves and are less flexible in terms of choice, whereas

Figure 4.16 GDP vs. passenger transport intensity in EU



Source: Eurostat, 2008.

([11]) Studies show that income is closely related to people's value of time, in other words, how much in monetary terms people think their time is worth. Transport services which allow a reduction in journey time (e.g. cars, high-speed rail and aviation) are therefore strong candidates for growth from this respect. This is related to the issue on constant time budgets.

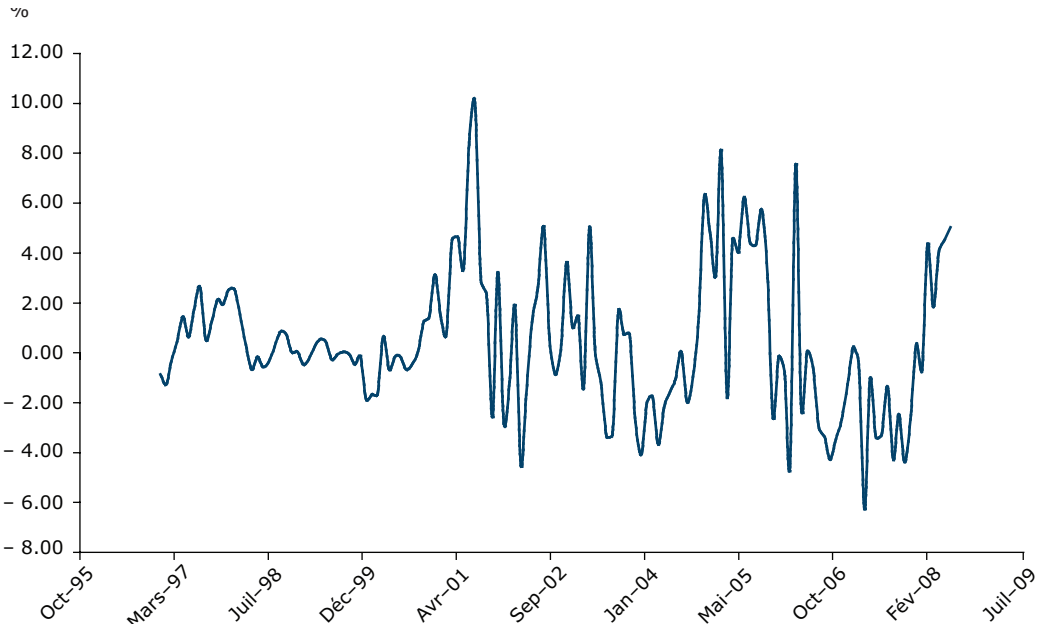
([12]) In economic jargon, the income elasticity of air travel demand is 1.5 for short-haul, and 1.7 for long haul. Elasticities are basically measures of sensitivity of one variable against another. In the case of income elasticity, the sensitivity of demand with respect to changes in income is being measured.

([13]) This figure is for changes in the average price of air fares at a national level. See InterVISTAS (2007) for full methodology, found at http://www.iata.org/NR/rdonlyres/0E7F6834-2506-498B-9CB9-8DCA198FA3BC/0/Intervistas_Elasticity_Study_2007.pdf

leisure travellers are more likely to respond to a fare increase by either not travelling at all, or changing where or how they travel. Furthermore, the effect of reduced price of flights is likely to diminish after a certain level, as the decision as to whether to fly would increasingly be governed by other factors such as cost of accommodation at the destination.

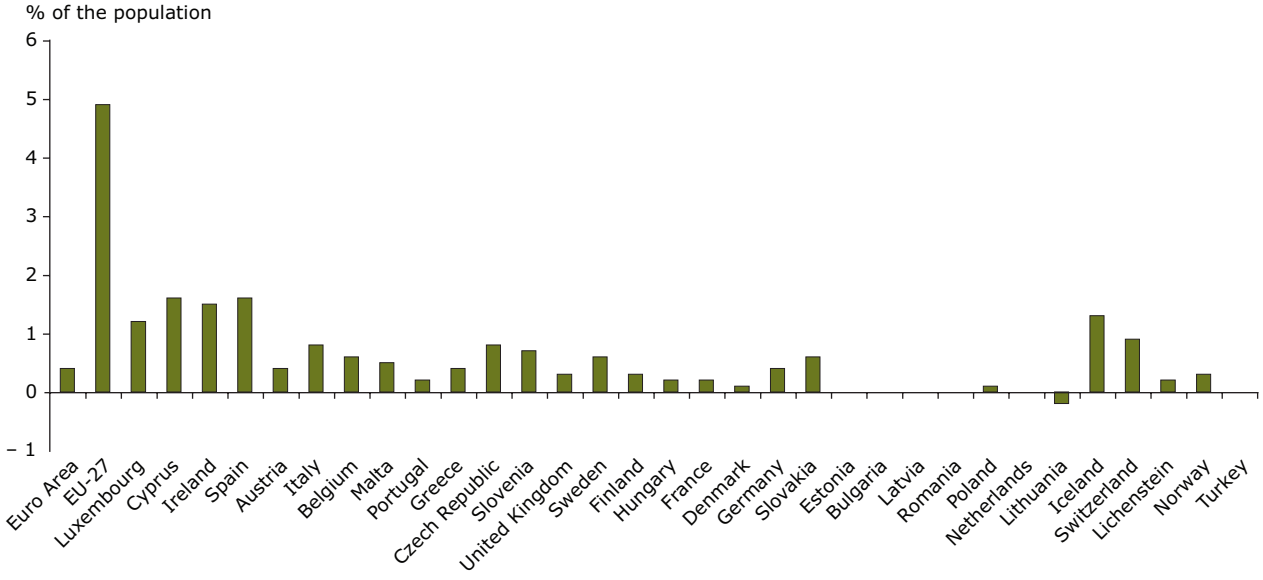
As depicted in Figure 4.17, trends until recently indicated a fall in the price of air travel in real terms, symbolised by the rise of low-cost carriers. The continued liberalisation of the market (i.e. through the internal market and the upcoming transatlantic 'Open Skies' agreement) is expected to put a downward pressure on prices through increased competition. On the other hand, increasing fuel prices, scarcity of landing slots, and costs associated with security as well as an increase in taxes (e.g. the Air Passenger Duty in the United Kingdom) is likely to place an upwards pressure on fares as seen in the data of 2008.

Figure 4.17 Changes to ticket prices in the EU



Sources: Cairns and Newson (2006) and Eurocontrol (2008).

Figure 4.18 Net migration across Europe



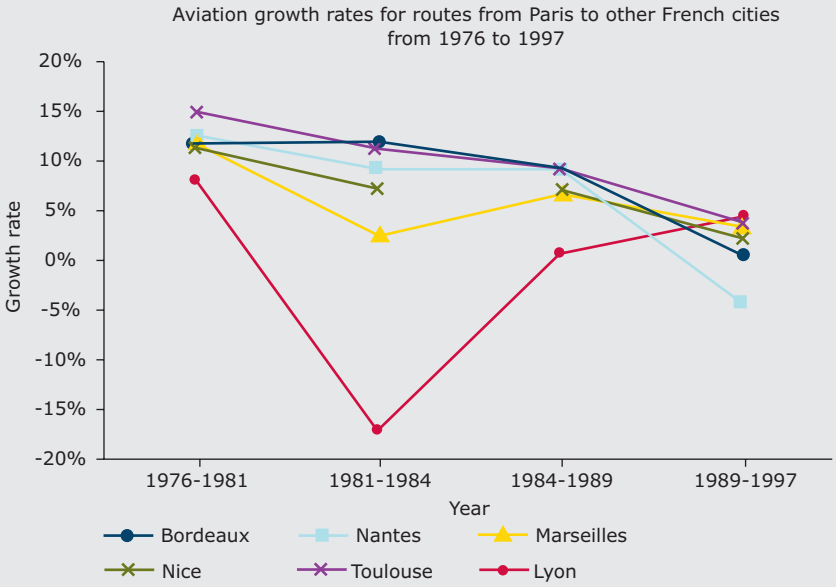
Source: Eurostat, 2008.

Box 3 Can high-speed rail reduce the demand for air travel?

there is an ongoing debate on whether the strong growth of air travel can be mitigated, or at least dampened by improvements of other modes, most notably high speed rail. The evidence suggests that there is scope for such a shift, although a full substitution may not happen in all cases.

Train services with a journey time not exceeding three hours are shown to compete effectively with air services (González-Savignat, 2004; Patterson and Perl, 1999). Studies involving the French TGV services imply that high speed rail can impact strongly on aviation growth rates. Figure 4.19 illustrates a strong dip in air travel demand between Paris and Lyon when the TGV route opened in 1981 (Patterson and Perl, 1999).

Figure 4.19 The TGV has shown to impact air travel demand



Source: Patterson and Perl, 1999.

A study by the EC (2006a) predicted that the inclusion of aviation in the EU Emissions Trading Scheme, with an estimated allowance price of EUR 30/tCO_2 in 2020 (equivalent to a 4 % increase in air fares) would reduce overall demand for air transport by 1.5 %, 14 % of which would be picked up by other modes: passenger train demand would increase by 0.3 % and coach by 0.1 % (see Table 4.6). This suggests that rail travel may offer a limited level of substitution for air travel, although the magnitude of substitution may increase with further investments in rail, such as the Trans-European-Network.

Table 4.6 Modelled impact of including aviation in the EU ETS

Transport mode	Passenger transport demand (billion passenger kilometres)		
	Base case in 2020	Impact of cost increase (EUR 30/tCO_2) in 2020	% change
Aviation	609	600	-1.5 %
Passenger train	435	437	0.3 %
Coach	347	347	0.1 %
Other passenger transport modes	6,950	6,949	-0.01 %
Total for all modes	8,341	8,333	-0.1 %

Source: Crains and Newson, 2006.

Socio-demographic factors

The movement and relocation of people is a key factor underpinning demand for air travel. For example, the enlargement of the European Union has given new freedoms to people in the Central and Eastern European countries on where to work and live. As highlighted in the previous section, there has been a rapid expansion of air traffic routes that link the CEE countries with Western Europe. Increased migration and immigration are being experienced all across Europe, as depicted in Figure 5.18. As people decide to live and work away from their region of origin, there is likely to be an increase in travel to meet friends and family.

Spatial factors

Factors such as the distance to the airport from the home or workplace may also have an effect on peoples' flying decisions. The recent growth of regional airports, used in particular by low-cost airlines, makes it possible for people to fly from their local airport, rather than travelling to the major hubs.

Proximity to the airport determines the overall distance and journey time from the trip origin to the destination. It also affects the total financial costs (e.g. amount spent on train fare to the airport) of the overall journey. This is one of the reasons why an increasing number of businesses decide to locate in close proximity to airports. The regionalisation/ localisation of airports is also likely to lower the overall costs to the average leisure traveller, and hence place an upwards pressure on demand.

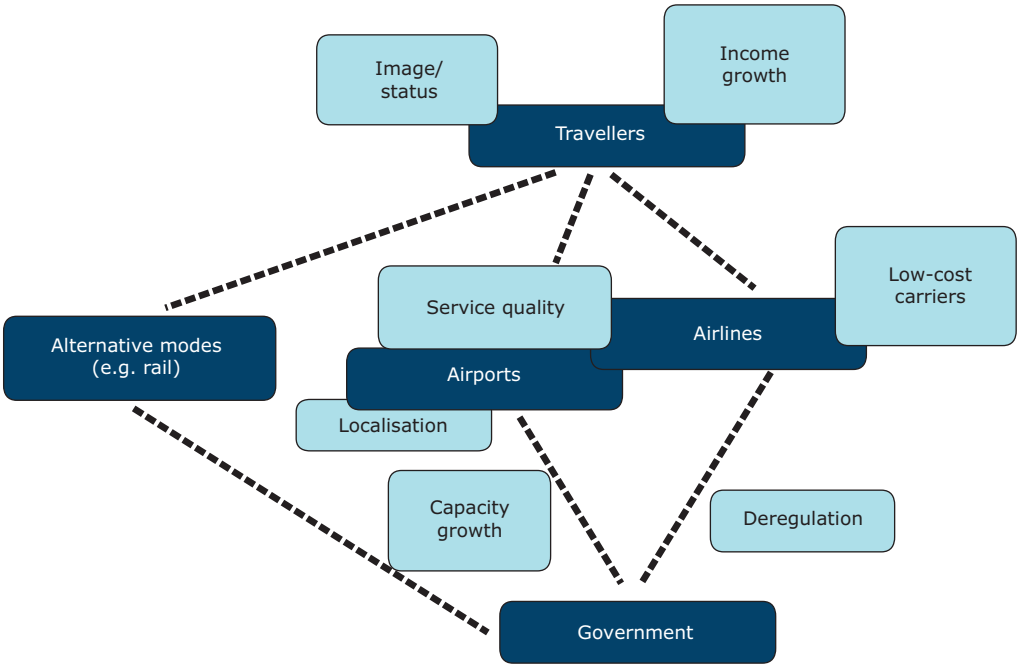
Geography, in conjunction with demography, may also affect the competitiveness of alternative modes of transport, such as high-speed rail. In Givoni (2006), it is noted that an HST line is commercially viable between major urban agglomerations with over one million population, when such agglomerations are disposed along linear corridors with cities spaced at approximately 200 km intervals (Hall, 1999) and when demand is between 12 million and 15 million passengers per annum between two urban centres (Vickerman, 1997).

Cultural factors

Cultural factors, such as **image** and **status** may also be elements that affect the demand for air travel. Aviation is often linked with a high-profile, glamorous image (see Sewill, 2005). Marketing efforts by the aviation and tourism industries are likely to add to this perception.

Flying frequently on business is often portrayed as a symbol of executive status, characterised by the phrase 'jet-set'.

Figure 4.20 Summary of factors influencing short-haul air travel



For leisure travel, as Tol (2006) suggests, most people would see a foreign holiday in a different light to a domestic one and hence the two would not be completely substitutable.

Summary

The above discussions on the various factors can be applied to summarise the current situation surrounding the business and tourism sector.

Business travel by air continues to expand, due to the increased accessibility of airports, lower prices brought about by deregulation and more importantly the journey time savings that air travel offers above alternative modes, at least in perception.

Leisure trips by air is encouraged by growing disposable income, lower prices of tickets, the expansion of the EU (which has increased the movement and relocation of people, especially from the CEE countries), and easier access to airports. The image of flying is still positive, and non-domestic holidays are often perceived to be superior to domestic ones.

4.2.5 Possible actions by actor

Earlier sections highlighted the rapidly growing demand for air transport, and the potential spiral of ever-increasing dependence on flying for both business and leisure purposes. However, as Cairns and Newson (2006) point out, air travel is still not an everyday activity, at least for most people. Acting early to avoid a large level of dependence in the future is likely to be both cost effective and publicly acceptable. The more people adapt to new levels of air travel, the more difficult it will become to change behaviour and reduce demand.

Tackling the rapid expansion of aviation demand necessitates action from a multitude of actors, including the EU, national governments, local/ regional bodies as well as the industry itself. The below sections summarise the actions needed by each actor to increase the sustainability of both businesses and tourism.

The EU and national governments

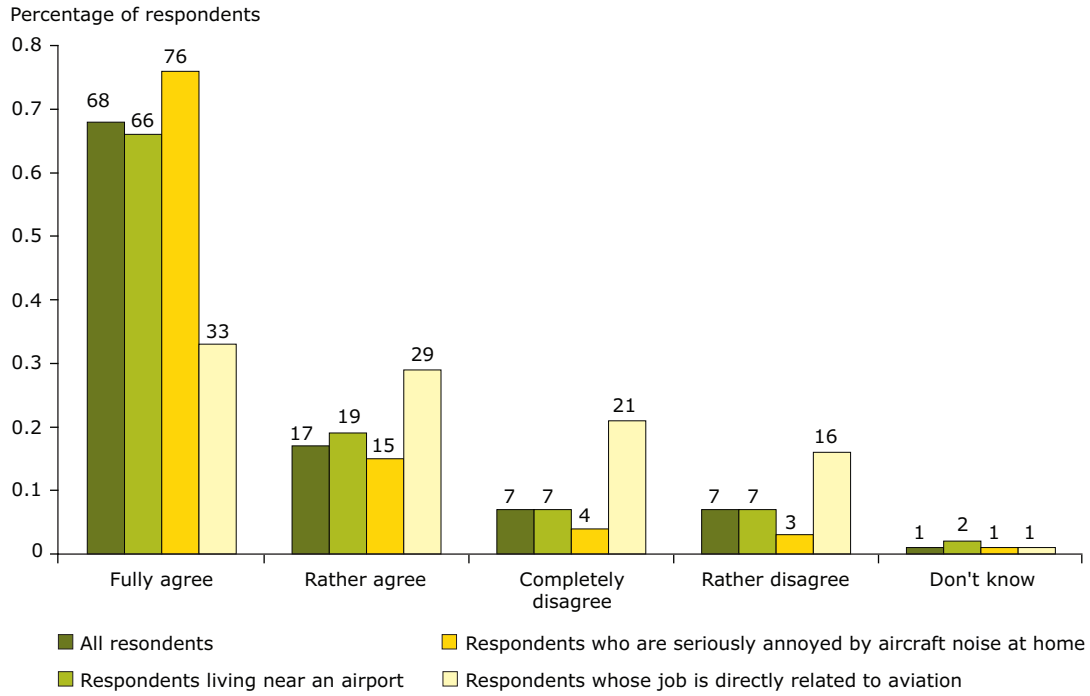
The EU, with the cooperation of individual national governments, has a major role in setting out the rules of the industry, and taking a long-term view on the development of the aviation industry.

Fiscal measures to internalise the external costs of air travel would be an important element in rationalising demand, although they alone will not guarantee an absolute reduction in aviation travel. Policy instruments include the emissions trading scheme (ETS), taxation of jet fuels, passenger duties and landing fees. The instrument or set of instruments would be ideally designed so as to fully internalise the externalities of aviation, including noise, air pollution and climate change (see CE Delft, 2008). On a practical level, consideration should be given to reduce the administrative, or transaction costs of such schemes. A balance would need to be struck between level of sophistication and ease of administration. Harmonisation of these measures across the region would mitigate the danger of creating loopholes; for example, a fuel tax in one country may lead to airlines refuelling in other nearby countries. Results from an EU survey of individuals suggest that the public support for such measures is high (see Figure 4.21).

The EU is on a path to include aviation into its ETS in January 2012. Allowances would be determined at Community level and capped at 100 % of average emissions from the sector between 2004 and 2006, which will then be allocated to airlines free of charge according to a harmonised efficiency benchmark, although 10 % would be left for auctioning and revenues would be used for combating climate change (EC, 2007d). It is important to note that although inclusion of aviation in the ETS is a step towards internalising externalities, this on its own will not imply absolute reductions in air passenger demand. The aviation industry could be a net buyer of allowances from other sectors. The effectiveness and fairness of the ETS has been questioned by some. Tol (2008) and Sewill (2005) argue that the currently proposed method of allocating allowances is in effect a subsidy to the sector at the public cost.

A separate, yet closely related issue concerns charges for the use of aviation infrastructure. Here, there are discrepancies between various airports that reflect their different circumstances. For instance, **landing charges** at regional airports are set at a very low level to attract airlines, often with the help of public subsidies. On the other hand, **landing slots** attract a heavy premium at major hub airports, where slots have historically been 'grandfathered' to a limited number of airlines, e.g. British Airways receiving a large number of slots at Heathrow Airport. Also, landing charges at larger airports are sometimes determined by the so-called 'single till approach' in which revenues and costs from both aeronautical

Figure 4.21 Perceptions towards internalising the aviation cost of climate change



Source: EC, 2005.

activities (i.e. aircraft operations) and commercial activities (i.e. retail in terminals) are combined to determine the maximum profit level allowed by their regulators([14]) — this often means that landing charges are often subsidised by revenues from retail activity. Such issues are closely related to air travel demand; in the former case this may encourage the opening of new routes and/or increased service frequency at regional airports, and in the latter case it may encourage incumbent operators to maintain current routes for the sake of keeping slots to themselves.

National governments could reform the way in which landing charges are set and landing slots are allocated. For instance, the level of charges could in theory be linked to the environmental performance of each flight. This would need to be considered in conjunction with the other types of fiscal instruments listed earlier, to maintain consistency and avoid duplication of charges. Reform of landing slot allocation may be limited in its consequences to air traffic demand, but may help reduce congestion and relieve pressures on increasing airport and runway capacity (see Cairns and Newson, 2006 for an extensive discussion).

A combination of the above economic measures is likely to impact the prices of air fares, through which demand would be rationalised. As stated earlier, a rise in prices is likely to create a larger effect on leisure travellers, due to their higher price elasticity of demand.

The EU may also help **streamline air traffic management,** which would contribute to increased operational efficiency. Currently, flight patterns are made inefficient by the complex airspace structures — rationalisation of airspace is one of the key objectives of the Single European Sky initiative (Eurocontrol, 2006b). It is estimated that enhanced air traffic management would have the potential to save 6-12 % of total fuel consumption globally (IPCC, 1999 in Cairns and Newson, 2006). However, as in other transport sectors, the environmental benefits of operational efficiency may be eroded by increases in traffic made possible from the improvements (see Chapter 2 for a discussion on the rebound effect).

Better provision and coordination of **alternative modes** (e.g. high speed rail) may also lower the pressure on short haul air travel demand, without

([14]) In the United Kingdom, the Civil Aviation Authority (CAA) regulates profits at Heathrow, Gatwick, Stansted and Manchester airports in this manner.

compromising the needs of businesses and leisure travellers. This would include measures to harmonise and simplify ticketing, especially for international rail services and connecting local services.

It was previously mentioned that high speed rail has the potential to substitute short haul flights to a certain extent. Givoni and Banister (2006) show that the aviation sector can work more effectively with rail operators to create an integrated network, whereby air operators would use railway lines (preferably high speed rail) as spokes in their service network from a hub airport. By complementing and substituting existing air routes, this would increase service quality at less environmental cost (e.g. compared with runway expansion). Ticketing can also be integrated between the two modes. As Givoni and Banister (2006) point out, the European Union may assist the development of such a network through the TEN, by ensuring HST stations are provided at the major European hub airports. However, the development of such a network may in some cases lead to increased demand for both air and rail transport. A thorough analysis of such a system is therefore recommended, in order to guarantee a positive impact on the environment.

Finally, providing consumers with **information** about the carbon footprint of their journeys may also be considered. For example, Sewill (2005) amongst others advocates the further provision of information to educate the public, including the mandatory provision of information on CO_2 emissions when booking flights. The exact effect of increased information is yet to be quantified, and warrants further research.

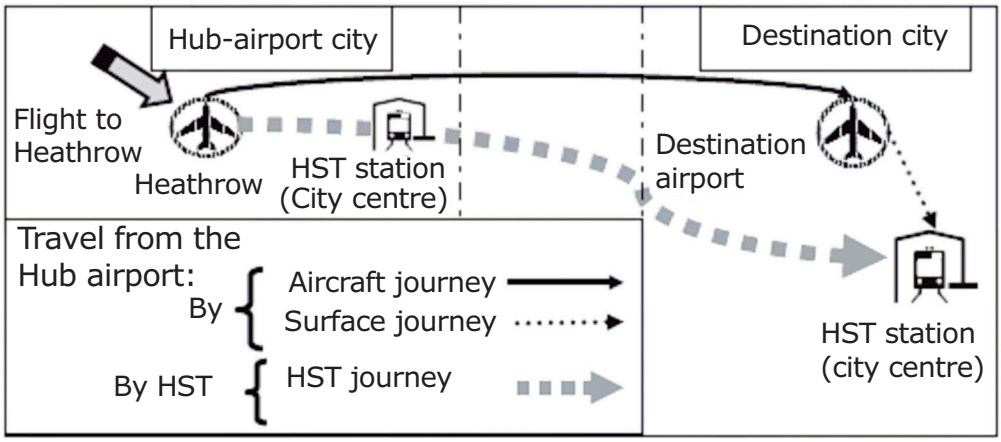
Local and regional bodies

Local development strategies and regional planning play a key role in managing the demand for air travel. As CE Delft (2008) points out, both the economic benefits of aviation and external costs (e.g. noise and air pollution) are to a large extent borne locally, and are therefore issues that necessitate effective policies on a local level.

As previously stated, there is currently an emphasis on aviation-led economic growth, under the assumption that more air travel will benefit the local and regional economy. However, the evidence base for this is weak, if not mixed. For example, CE Delft (2008) suggests that the economic benefits of air travel are often overstated. Structural unemployment resulting in jobs not created by the aviation sector could be compensated for by jobs creared elsewhere in the economy. Money spent by customers for aviation could also be spent for other purposes, growing other sectors in the economy. The increased ability of domestic producers to sell goods to a wider audience is accompanied by foreign producers selling their products on the domestic market; hence increased trade may not always be a good measure of economic benefits.

Overall, local and regional bodies may want to re-examine their economic development strategy, incorporating the issues listed above. For instance, public money currently spent on aviation could be spent for other purposes, such as health and education, to increase employment in those sectors and increase the quality of life of local citizens.

Figure 4.22 The concept of air and rail integration



Source: Reproduced with kind permission of Givoni and Banister, 2006.

The business sector

Accessibility to the wider European and global market was described as a large factor for the reliance of businesses on aviation. However, the development of **alternative technologies** such as remote conferencing and online meetings could serve similar functions, and may reduce the need to travel physically. The evidence currently available suggests that telecommunications and aviation are often compliments to travel rather than substitutes (see Banister, 2006), although some substitution can be expected in certain contexts. It can be assumed that the potential for substitution of air travel for telecommunications is likely to increase in the future as the technology becomes increasingly reliable, affordable and of high quality, and as employees adopt and assimilate ICT. The increasing emphasis upon corporate responsibility and the carbon footprint of organisations could also increase the likelihood of organisations seeking alternatives to business air travel. There are reasons to believe that the scarcity of time, which was mentioned earlier as a key factor driving business air travel, could even favour telecommunication above physical travel, and that it could act as a cost reduction strategy in some circumstances.

A recent survey of 100 of the FTSE 350 companies conducted by WWF (2008) supports the contention that a substitution of business air travel with ICT will be experienced in the future. The research found that 86 % of the organisations claim to be actively seeking to reduce their carbon footprint, and that over 70 % of the companies either had or were developing a corporate policy which encourages green business air travel. Eighty-five percent of the companies agreed with the statement that videoconferencing has the potential to reduce the number of flights undertaken by their organisation.

The tourism sector

Cairns and Newson (2006) mention that increased tourism is often a two-edged sword in that the development of aviation facilities may lead to a loss of potential revenue from domestic travellers as they decide to travel abroad. Resources could alternatively be spent by the tourism sector on developing and marketing local tourism, to ensure that high-quality, attractive options are made available domestically to potential users of air travel. Such efforts are likely to work best when the tourism sector can work effectively with local and regional governments, who have an obvious interest in promoting the local economy in a sustainable manner.

AET (2008) highlights several examples of where sustainable travel has been promoted in the context of tourism, including efforts to provide effective public transport information in Manchester, and the reinstatement/coordination of railway routes between the Palatine and Alsace, which was accompanied by information campaigns in both the German and French languages. Partnerships between cities may also prove effective in disseminating best practice. For example, the partly EU funded SUVOT (Sustainable and Vocational Tourism) programme aims to rejuvenate traditional tourist destinations, create sustainable products and disseminate best practice between its member cities.

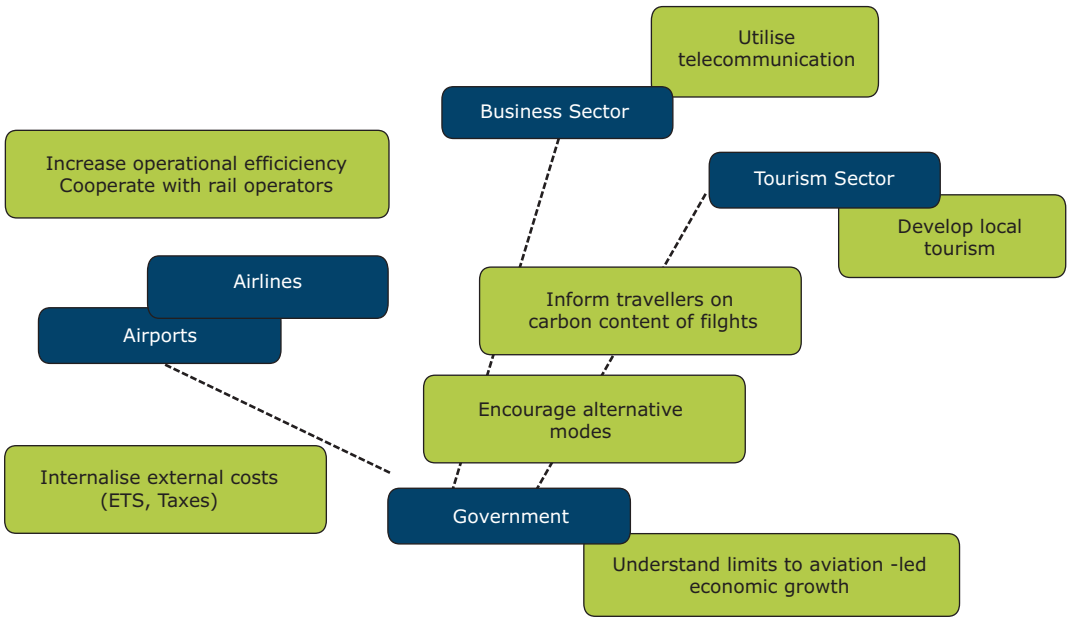
The aviation industry

The aviation industry itself can also work collectively to ensure the environmental efficiency of their services. **Loading factors** and **operational efficiency** are already at high levels, especially for low-cost airlines. Measures to further increase efficiency would be of financial as well as environmental benefit, thereby less controversial to the industry. For instance, IPCC (1999) in Cairns and Newson (2006) list increased load factors, elimination of non-essential weight, optimisation of aircraft speed, limitation of the use of auxiliary power, and reduction in taxiing on the ground as such measures.

To its credit, the industry has invested in new technologies that increase the fuel efficiency of aircraft. It also has ambitious targets for drastic improvements in the future. However, RCEP (2002) and others note that improvements in performance are likely to be incremental, at least for the foreseeable future. The use of alternatives to kerosene-based fuels was also regarded as impracticable for the next several decades by the IPCC (1999). In this light, the industry must step up developments in technologies that enable larger efficiency gains to be met.

Meanwhile, as explained previously, airlines can work effectively with rail operators to expand their service network and provide a better quality of service.

Figure 4.23 Summary of solutions for short-haul air travel



4.3 Effects of education based travel on transport demand

Trends across Europe indicate an increase in journeys to school by car, which mirrors the rise in the level of car ownership in European countries, particularly in the eastern and central European countries. This is often linked to several negative consequences, including increased transport emissions, reduced road safety, and growing child obesity.

The way children travel to school is often dictated by the choices of parents, school requirements and educational policy in general. Rarely do children decide on their own when and how to travel. For example, the school a child travels to is decided upon by a combination of parents' wishes (e.g. public versus private, local versus non-local) and governmental policy (i.e. school districts, school size, consolidation of schools). This calls for an even greater understanding of the underlining factors that influence school travel, and policies that may help manage demand.

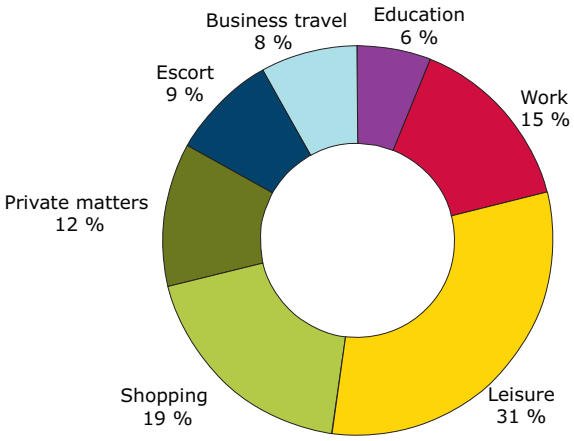
This section aims to highlight how education based travel transcends across a variety of issues, and how managing its demand can deliver positive outcomes not only in transport terms, but also in health, environment and road safety.

4.3.1 How it affects transport demand

Trips made for school purposes typically constitute a small fraction of total transport demand. For example Figure 4.24 shows that travel for education only accounts for a small percentage of travel flows in Germany.

However, the timing of school journeys is a reason for concern. School traffic flows often coincide with peak traffic flows, which can contribute to morning peak-time road congestion. Congestion in turn

Figure 4.24 Transport volume by journey purpose in Germany in 2005



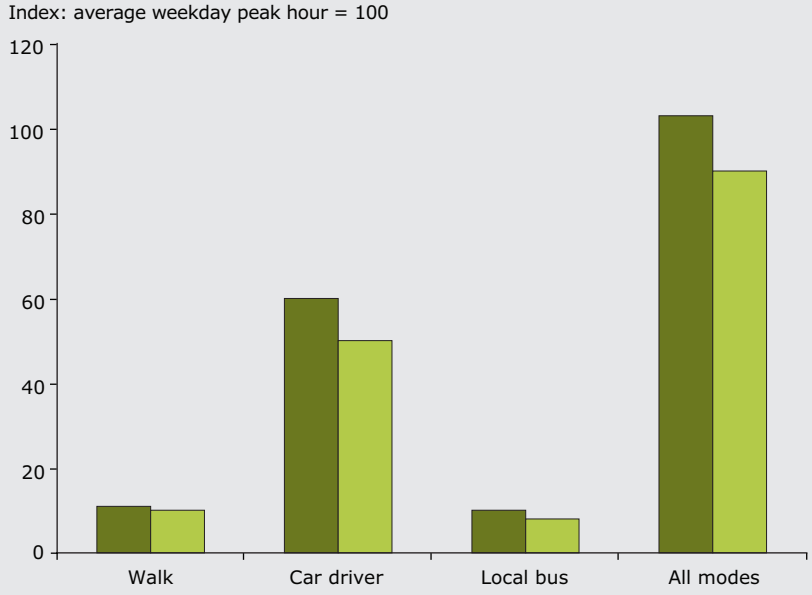
Source: DIW, 2006.

Box 4 Peak period congestion and the 'school run' in the United Kingdom

The importance of addressing school journeys is supported by statistics produced by the UK National Travel Survey (NTS). In 2006 the 'school run' accounted for 18 % of car trips by residents of urban areas during term time. The variance in traffic between term – time and school holiday periods is shown in Figure 4.25. Commuting trips during the morning peak hour (8–8.59 am) reduced by 15 % during the school holidays compared to term time, with a 17 % reduction in car commuting trips during the holiday period (NS and DfT, 2008).

This percentage decline in car commuting trips during holiday periods is comparable to the 16 % reduction in traffic flows seen in central London resulting from the Congestion Charge (four years after implementation in 2002). This shows the potential impact of reducing car travel to school, for example through school travel plans (see Box 8).

Figure 4.25 Commuting trips in progress during the peak hour term-time and school holiday periods



Source: NS and DfT, 2008.

results in more emissions, noise, loss in valuable time and increased stress levels.

It is also considered that habits children develop in their youths may affect how they choose to travel later in their lives. For example those who are accustomed to the car are unlikely to change modes in their adult lives (Cairns *et al.*, 2004b). This is often because there is an ingrained reluctance to change where children grow up seeing the benefits of the car such as convenience, safety, protection from weather etc. rather than the negative implications such as vehicle emissions, congestion and the risk of obesity. Likewise, children who are accustomed to cycling, walking or using public transport are more likely to continue to do so in the future, as they have both the experience and the awareness of using these modes.

Additionally, the impact of cars as the preferred mode of travel to and from school for children is significant in terms of its impact on local investment decisions. Higher pressure may be placed on local authorities to supply infrastructure that is suitable to cope with the increased number of vehicles. Schemes to improve the safety of the roads and footways for children such as traffic calming, low-speed zones, safer controlled crossings and cycle lanes will also need to be installed (Cairns *et al.*, 2004b).

4.3.2 Recent trends

There is relatively limited data and information to describe the trends in educational travel and its effects on transport demand at a European level. Therefore, focus will be given to two particular regions where the most data is available; the region of Wallonia in Belgium and the United Kingdom.

Modal choice of school children over time

The mode of transport used by students travelling to and from school has changed notably over time. This can be seen in statistics provided by the Institut National de la Statistique (INS) for the region of Wallonia in Belgium for the years 1981, 1991 and 1999.

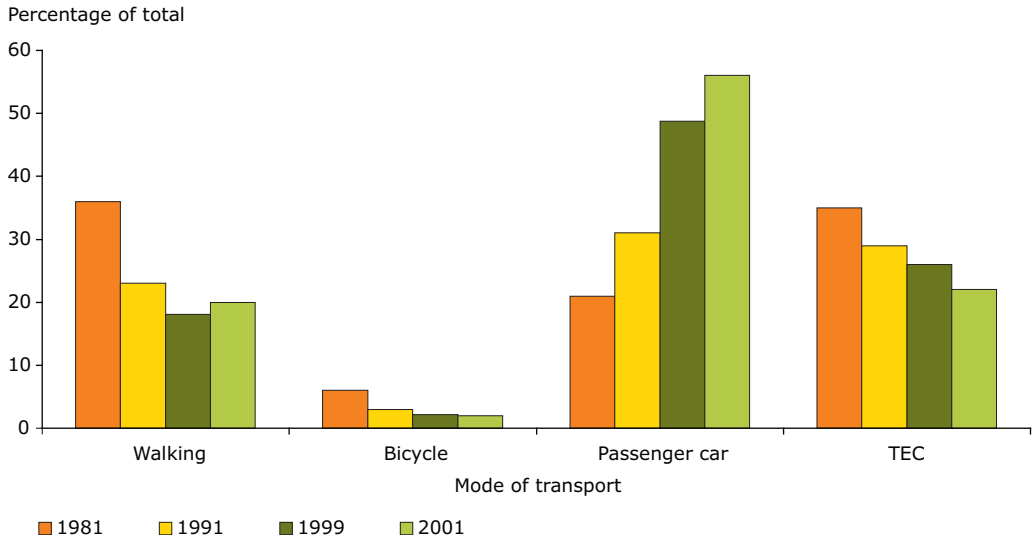
From 1981 to 1999 there has been a significant increase (27 percent-point) in the number of school children in the region of Wallonia travelling to school as a passenger in a car. There was a reduction travelling to school by bike (-4 percent-point) and those walking to school (-18 percent-point). Explanations include the increased concern for children's road safety, development of car orientated road infrastructure and the increase in the number of cars owned per household (MET, 2003).

Trends in recent years are somewhat different in the United Kingdom. The proportion of primary school children walking to school in 2005 (52 %) is almost the same as the figures for 1995/1997. For the same age group, the proportion travelling to school by car has increased slightly from 38 % in 1995/1997 to 41 % in 2006. In the United Kingdom, the long term decline in walking to school and increase in travelling by car seems to have levelled off (NS and DfT, 2008).

Similarly, trips to school made on foot in the United Kingdom by older children, aged 11 to 16 (secondary school), remained at a level of just over 40 % between 1995 and 2005. For this age group, the percentage travelling to school by car remained at 20 % but there was a small decline in those using a bus from 33 % in 1996/1997 to 31 % in 2006 (NS and DfT, 2008).

In highlighting the differences in trends between the Belgian and UK statistics, it should be noted that care must be taken when comparing different regional circumstances and time periods. In Belgium the percentage of school children walking to school declined to 18 % but the percentages for both primary and secondary school children walking to school in the United Kingdom has stayed relatively high over the three years at 52 % and 41 % respectively. However, that both examples show that car use as a mode of transport to and from school has increased is cause for concern. Possible explanations for this include: increased concerns about road safety, increased distances between home and school (thus increased journey times), and an increase in the variety of schools available, all of which are discussed later in this section.

Figure 4.26 Transport volume by different modal type over time in Wallonia, Belgium



Source: MET, 2003.

It is important to address the decline in levels of walking and cycling by school children, particularly in Eastern Europe where current levels of car ownership are growing fast. There, parents may increasingly include the school run as part of a wider journey (i.e. a journey to work or the shops). The increase in the number of cars may also lead to an increased concern for children's road safety, whereby parents may feel the need to escort their children in their cars, an issue that will be re-examined in a later section.

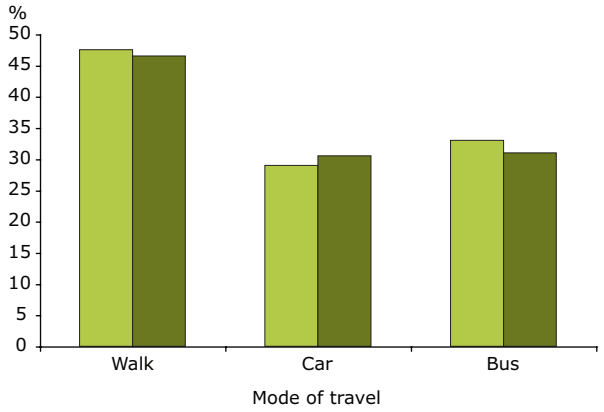
4.3.3 Interactions with other sectors

School travel has the potential to interact with a number of sectors, including health, safety, the environment and transport.

Educational travel and health

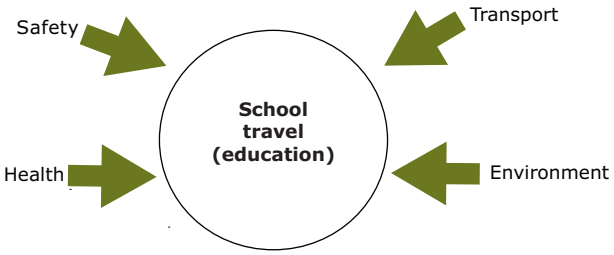
The decreasing numbers of children walking or cycling can have a serious impact on their physical health and mental well-being. Furthermore there is a potential reduction in children's ability to socialize on the way to school whilst getting adequate daily exercise. It is widely known that falling levels of exercise can contribute to growing levels of obesity in children and young adults. Globally, child obesity rates have tripled during the last 20 years. In 2000, 10 % of six-year olds in the United Kingdom and 17 % of 15 year olds were obese, and in accordance with current trends, 50 % of children could be obese by 2020 (ESRC, 2008). Other European Countries such as Iceland also have steadily increasing obesity rates. Child obesity is now becoming a significant issue in a number of European and other world countries (Government office for Science, 2007).

Figure 4.27 Trends in mode of travel to school in the United Kingdom between 1997 and 2006



Source: NS and DfT, 2008.

Figure 4.28 School travel is linked to various sectors



Educational travel and safety

With an increase in road traffic, children are exposed to higher levels of traffic. According to the World Health Organisation, over two million traffic accidents resulted in 120,000 deaths and 2.5 million injured people in the whole European region. Approximately one in every three road traffic deaths involved people less than 25 years of age; pedestrians and cyclists are considered the most vulnerable making up 50 % of all road deaths in Hungary, 45 % in the United Kingdom and 30 % in Denmark and the Netherlands. With these statistics in mind, it is understandable that parents are now more wary of allowing children to travel to school by foot or by bike, with the perception that taking them to school by car is a safer option.

Educational travel and the environment

Globally, there are direct links between the increase in car use and the increase in CO_2, despite increased fuel efficiencies and alternative energy sources. Increases in the numbers of motor vehicles also have more localized effects on air pollution. Exhaust fumes from vehicles contain a mixture of chemical including carbon monoxide, oxides of nitrogen, volatile organic compounds (VOCs) and particulates (PM_{10} etc.), all of which are harmful to health when emitted into the environment (Hampshire County Council, 2007).

Reducing traffic outside a school can also have a positive effect on students due the reduction in noise and improvement in air quality. They can also help globally to some extent, as a reduction in the number of cars results in fewer carbon emissions being emitted into the air.

The links between the education, health and safety and transport sectors can be seen in the case study

Box 5 Links between education, health and safety and transport — A case study of the Piedibus from Lecco, Italy

The Lecco local Health Service of, Italy has proposed a scheme called Piedibus (Walking School Bus) in which children are picked up by adults on foot and escorted to and from school in groups. This has the objective of ensuring safe passage for children from home to school, and with a fundamental focus on increasing the levels of physical activity among children. At present 12 lines are operational in the Lecco area, with more than 500 children using the routes.

Feedback on the scheme has been very positive, with the Piedibus being the preferred mode of transport to school for 87.4 % of children (Table 4.7).

Table 4.7 Preferred means of transport for children in the region of Lecco, Italy

Transport means	Number of respondents	%	% cumulative
Pedestrians	90	87.4	87.4
Vehicle	3	2.9	90.3
I don't know	10	9.7	100.0

Source: Rossi *et al*, 2004.

The reactions of both teachers and accompanying volunteers are presented in Table 5.9. Some of the positive feedbacks of the scheme include; reduction in traffic congestion, increased socialization and a reduction in pollution. Negative views of the scheme were that the Pedibus is exposed to adverse weather conditions, and that children may have to carry heavy rucksacks. One person was even concerned that the children may experience fatigue when walking.

Table 4.8 Positive and negative aspects of the project according to teachers and accompanying volunteers

Positive aspects	Number of respondents	%	Negative aspects	Number of respondents	%
Socialising	30	21.0	Adverse climatic conditions	35	49.3
Combating inactivity	30	21.0	Heavy backpacks	25	35.2
Road awareness	18	12.6	None	8	11.3
Enhancement of community project	16	11.2	Children's fatigue	1	1.4
Education on mobility	16	11.2	Lack of respect of motorists	2	2.8
Reduction of traffic congestion	15	10.5			
Education of pollution	8	5.6			
Learning about surrondings	7	4.9			
Other responses	3	2.1			
Total responses	**143**	**100.0**		**71**	**100.0**

Source: Rossi *et al*, 2004.

below regarding the Piedibus 'Walking School Bus' of Lecco in Italy (see Box 5).

4.3.4 Influencing factors

When addressing the demand for school travel, demand is influenced by a number of factors that can be split into social, spatial and economic. These factors can be considered as the key drivers for school transport demand.

Spatial factors

The **physical distance** between the school and home can strongly influence the numbers of children walking or cycling to school. It is generally accepted that the further away children live from schools, the less likely they are to either cycle or walk to school. As can be seen from Table 5.10 below, 81 % of primary school children in the United Kingdom walked to school if their journey was less than one mile, but this falls to 0 % if the distance is greater than three miles. For primary school children the car was the most popular mode for any distance greater than one mile (NS and DfT, 2008).

Walking to school is the most popular mode of transport for secondary school children in the United Kingdom, for any distance up to two miles, with 91 % of children walking if the distance is less than a mile and 61 % walking if the distance is between one and two miles. The most popular mode of transport for distances between two and three miles is by car at 40 %, with bus being the mode of choice for school children if the distance is between three to five miles (60 %) and also if distances exceed five miles (66 %).

This clearly indicates that secondary school children are less dependent on cars as a mode of transport to school compared to that of primary school children.

The research in Wallonia, Belgium, indicates that secondary schools are generally located further away from pupils than primary schools. Although travel patterns of the two groups are not directly comparable, this may partly explain the higher percentage of primary school children walking to school.

When looking at spatial factors it is important to consider that the preferred mode of transport used to travel to and from schools may vary according to whether the area is the urban or rural. There are clear differences between the demand for different transport modes between different areas even within a relatively small European country such as Belgium. For example, Table 5.12 compares the main modes of transport to and from school in three areas of Belgium: Wallonia, Flanders and Brussels and shows the clear difference between the three regions

School choice may affect the length and mode of trips to school. Parents often send their children to schools that are not local to them, out of choice. This is mainly because parents want to send their children to schools that are more specific to a child's needs (e.g. faith based, sports accredited or renowned for musical expertise). Parents may also want to send their children to a private school or one designed for children with special needs, all of which may not be in their local area. This can have negative implications with regard to the mode of transport used to travel to school. As discussed above, distances in excess of one mile result in

Table 4.9 Trips to school by distance and main mode in the United Kingdom (2005/2006)

	Age 5–10						Age 11–16					
	Under 1 mile	1 to under 2 miles	2 to under 3 miles	3 to under 5 miles	5 miles and over	All distances	Under 1 mile	1 to under 2 miles	2 to under 3 miles	3 to under 5 miles	5 miles and over	All distances
Walk	81	29	2	–	–	50	92	61	17	3	–	43
Bicycle	1	2	–	–	–	1	1	5	5	4	–	3
Car	18	62	83	79	67	42	6	22	40	29	24	21
Bus	–	7	13	19	24	6	1	12	35	60	66	30
Other	–	–	2	2	9	1	–	1	3	4	9	3
All modes	100	100	100	100	100	100	100	100	100	100	100	100

Note: This table includes trips under 50 miles only.

Source: NS and DfT, 2008.

the majority of primary school children being transported to school by car.

Reducing parents' choice of where they send their children to school would be one obvious solution, but this would involve restricting freedom of choice. The promotion of car-sharing schemes or school buses/ coaches could be a more widely accepted solution.

School closures, which effectively increase the average distance to the nearest school, can also have an effect on children's travel patterns. The impacts of school closures can, in some cases, be drastic for children and parents. An example of this is the potential closure of Llanedeyrn High, in South Wales. The alternative schools suggested by Cardiff Council; Llanishen High or Cardiff High would mean a 65 minute walk for students each way, an GBP 8 a week bus ticket involving catching two buses or being driven to school by car (WalesOnline, 2008).

Although beyond the scope of this study, the social impacts of school choice and school closures are also of importance.

In summary, spatial factors are crucial in understanding parents' and children's behaviour. Location of schools relative to pupils' homes not only affects the required distance to travel to school, but also how children travel to school. Spatial issues can therefore heavily affect the planning and feasibility of schemes and initiatives such as walking buses and cycling trains.

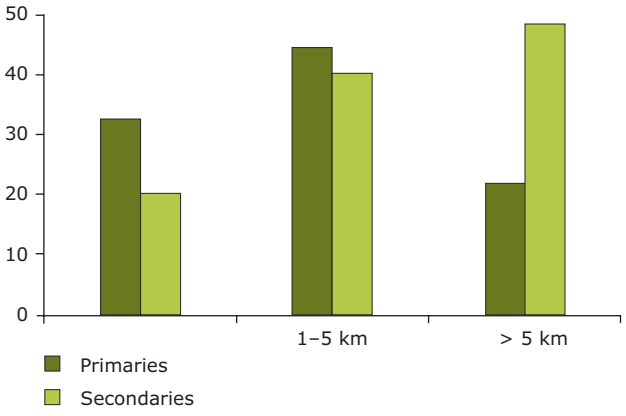
Social factors

Understanding the social and cultural factors that affect parents' decisions is crucial to reducing dependence on the car for educational travel.

To begin with, **concerns over children's safety and security** have contributed to the increase in the number of parents using cars to take their children to school. Figure 4.30 describes the views of parents within Belgium regarding the dangers of road safety.

The above example represents the thoughts of parents regarding driving the car to school and the spiral of decline that ensues. By driving cars to school, traffic increases, which reduces pedestrian (child) safety and subsequently reduces the quality of life for children. This in turn means more parents are inclined to use a car to take their children to school and thus the negative spiral continues.

Figure 4.29 Average distance from home to school for selected primary and secondary schools in Wallonia, Belgium



Source: MET, 2003.

Table 4.10 Regional differences for transport demand for children travelling to school in Belgium

Mode of transport	Wallonia	Flanders	Brussels
Car Passenger	48.8 %	27.9 %	28.4 %
Car Driver	4.3 %	4.35 %	3.2 %
Pedestrian	18.1 %	9.8 %	22.5 %
Cyclist	2.2 %	33.65 %	1.5 %
Public Transport	26.0 %	22.5 %	42.0 %
Other	0.6 %	1.8 %	2.4 %

Source: Generated from MET, 2003.

In some countries there is also an increase in the proportion of children who are accompanied to school by an adult due to c**oncerns about exposure to crime**. An example of this can be seen in the United Kingdom from the National Travel Statistics (see Table 4.11).

However, **concerns for the health of children,** increased socialisation and a way of tackling child obesity would be counter arguments against transporting children to school by car. In addition according to Cairns *et al.* (2004), walking and cycling to school increases children's appreciation of road safety and further assists in the development of key skills which are important for future independence.

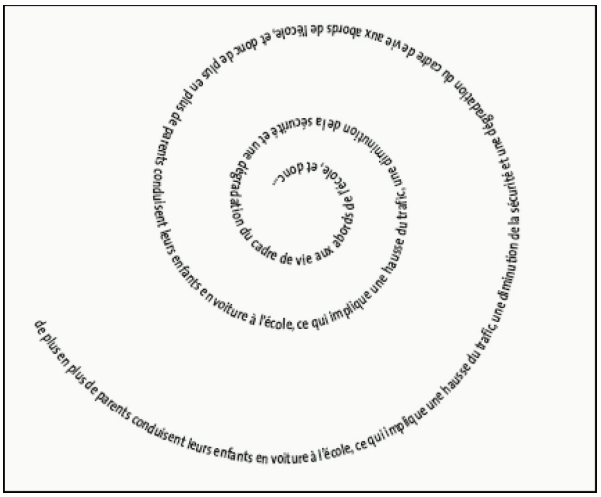
It can also be assumed that some parents may drop children at school as part of a larger journey to work (or other trip attractors such as supermarkets). This suggests the importance of examining **adults' travel behaviour** in conjunction with that of the children.

The expanding curriculum in a number of European countries and the increase in the number of subjects taught mean that there is a logistical problem with the equipment required. For example, a child that has music and sports commitments as well as educational obligations during the school day, may not have the ability to physically carry all items to school on foot, bicycle or public transport. Therefore parents may be forced to transport their children and equipment to school by car.

Economic factors

Gross household **income** may determine the mode of transport used to travel to and from school. Children who come from affluent families may attend schools outside their local area, which may be considered as being of a higher quality. Children in this situation are unlikely to travel to school by foot or bike and are likely to be driven by parents to and from school. This is also because high income families generally have more than one car per family and are therefore more likely to use a car as transport for the 'school run'. It may also be assumed that as household income increases, so does the parents' value of time. The quicker and more time efficient option of transporting children to school by car may therefore become attractive. Although car

Figure 4.30 Negative spiral of thought of parents in regards to road safety



Source: MET, 2003. Translation of the phrase: 'More and more of parents drive their children by car to school, which implies an increase in traffic, a decrease in security, a degradation of the quality of life on the journey to school and therefore more and more of parents drive their children by car to school which results in an increase in traffic, a decrease in security…'.

Table 4.11 Reasons children may be accompanied to school by an adult (2006)

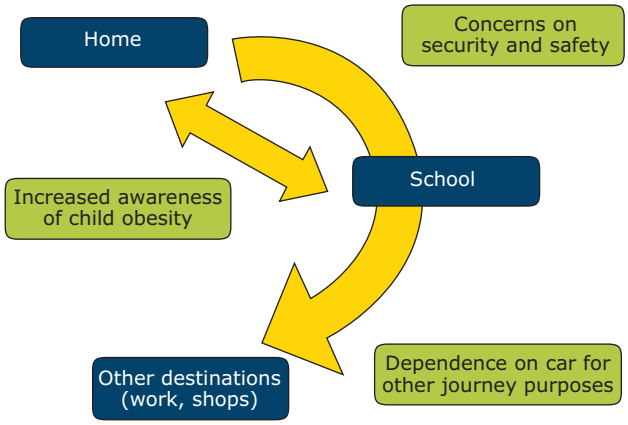
Reasoning	7 to 10 years	11 to 13 years
Traffic danger	59	32
Fear of assault/molestation	36	25
Convenient to accompany child	22	35
School too far away	20	25
Child might not arrive on time	16	12
Child might get lost	14	3
Fear of bullying	8	10
Other	13	17

Source: Generated from NS & DfT, 2008. % sum exceeds 100 as more than one reason may be given by one respondent.

ownership and usage is not solely driven by income, it is nevertheless a high predictor.

The cost of transport can be a significant factor in determining the mode of transport children use when travelling to school. Where public transport is free for children a greater number may choose to travel by these modes, especially when journeys are in excess of 2 km. Countries such as Belgium allow children, as well as other demographic groups, to travel on public transport such as buses, metro and tram for free. For example, in Ghent, Belgium children aged between six and 14 years are offered free travel on public transport, not only for school but for recreational purposes. Similar schemes are seen in Carmarthenshire in Wales, where children under the age of eight are provided with free transport if they live more than two miles from their home, and those that are over the age of eight are given free travel if they live in excess of three miles from their home. Similar schemes have been introduced elsewhere.

Figure 4.31 Key factors affecting the journey to school



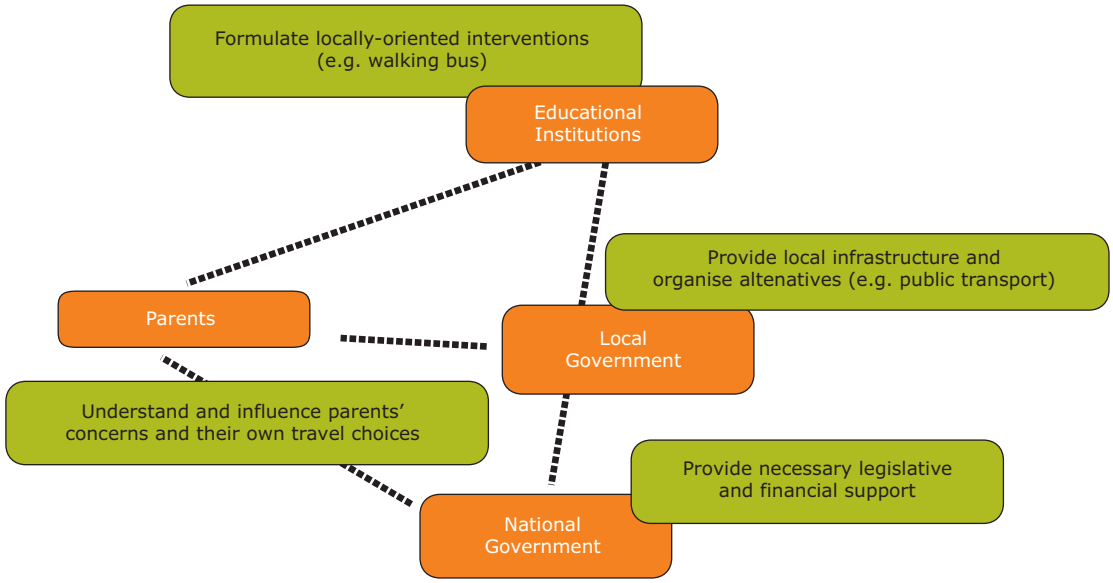
4.3.5 *Possible actions by actor*

Various actors and stakeholders can influence the journey to school. National governments, local/regional bodies, educational institutions and parents must work together to formulate solutions that are effective in reducing the demand for transport by car.

For example, a cycle lane may be required in order for school children to feel safer cycling to school. However in order for this to be installed the effective width of the footway may be required to be wider. The feasibility of widening a footway can depend upon factors such as the carriageway width, government guidelines or even the limited budget of the local authority. Joint working between the actors is therefore likely to be effective in addressing issues relating to educational travel.

School children, particularly those in primary school, are unlikely to make the final choice in regards to which mode of travel they use to travel to school. They are often limited to what their parents suggest or encourage them to use. If parents are ruled by inertia and opposed to change, regardless of developments made by a local

Figure 4.32 Summary of actions for reducing school travel by car



authority or school schemes they are unlikely to change their behaviours.

The above points highlight the importance of a joint approach that involves all stakeholders. The sections below set-out solutions classified by the principle actor involved; although the need for inputs and cooperation by other actors should be stressed.

National and local governments

National and local governments can support educational institutions and families by providing the necessary legislative environment, financial support, investing in local infrastructure and providing alternative modes of transport. At times it may be more appropriate to introduce actions at a regional level in order to focus on specific local requirements. This is particularly true in the context of increased devolution of power to the local government level, and the large regional variances in travel trends as observed earlier. Specific actions that can be taken by government include:

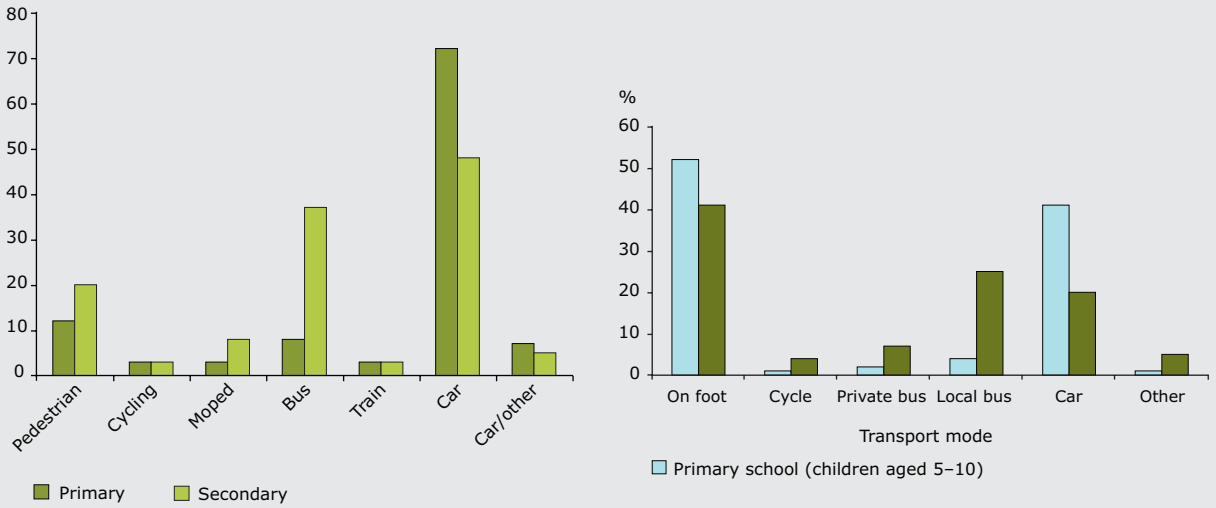
- Incorporation of transport impact assessments in educational decisions — The previous sections highlighted the large impact of school location on transport demand. To understand the implications of school choice and school closures for transport, impact assessments can be carried out at an early stage to identify potential problems and mitigate them wherever possible through other measures listed below. This would be needed on top of assessments on the social aspects of school choice and closures, as described earlier.

- Provision of infrastructure — Investing in cycle lanes, safe crossings and footpaths is likely

Box 6 Modal choice depending on age

Recent trends have shown that the mode used to travel to school can differ significantly depending upon the age range of the school children. Studies in the region of Wallonia in Belgium indicated that primary and secondary school pupils have different patterns of mobility. Figure 4.34 shows the varying use of modes dependent on the age for children in Wallonia.

Figure 4.33 Trips to school by mode in Wallonia, Belgium (left) and trips to school by main mode in the United Kingdom



Sources: MET, 2003; NS and DfT, 2008.

Similar conclusions can be drawn from statistics from the UK National Travel Survey, which indicate that a higher number of children aged 5–10 (primary) are taken to school by car compared to those in the 11—16 (secondary) age range. Secondary school children (11–16 age range) were also found to use local buses to a higher degree in both the UK and Belgian examples.

Box 7 School walking buses — Tremblay, France

Within the relatively rural region of Tremblay, France, there is a keen drive to reduce dependency on cars. In this region some children who live as little as 250 m away from schools were being taken there by car. In 2002, a school walking bus scheme was implemented in two of the schools where car dependence was highest — Victor Hugo and Andre Malraux. An accessibility study for each school was carried out in the summer looking at the local environment. Awareness of the current situation and benefits of the scheme were disseminated to parents through leaflets and questionnaires. The locations of houses responding to the questionnaire were studied to identify potential routes. The plan was to develop long lasting collaboration that was clearly communicated. Effective planning was undertaken including arranging jackets and luminous placards.

Local residents have noticed the positive effects of the walking buses which include reduced congestion and traffic flows around school opening and closing times.

The positive effects extend further than reducing the effects of congestion. The scheme was able to develop the social connections of children and also increase children's awareness of air pollution and smarter travel in the two schools. Children could reflect on their journeys from home to school, thus capturing their interest and highlighting that walking is better for the environment and good for their well being.

Sources: ARENE & ADEME, 2008.

Box 8 School travel plans

One measure which has the potential to address the increase in car usage as a mode for travelling to school is the school travel plan. A school travel plan is a type of travel plan designed to target children and reduce road traffic around schools. They have the ability to combine a package of measures, such as increased education of road safety, travel awareness, installation of cycle lanes, a walking-bus scheme or a car-sharing program. Key objectives of a school travel plan can include:

- Increased usage of cycling, walking, car sharing and walking bus;
- Increased road safety and travel awareness; and
- Increased awareness of alternative car parking arrangements.

School travel plans are increasingly being used in a number of European Countries, (Table 4.12).

Table 4.12 School travel plans in various European countries

Country	Name/scheme	Example area
Germany	Schulverkehrsplan	Munich
United Kingdom	Schulverkehrsplan	Surrey
Belgium	Schoolvervoerplan	Wallonia
Italy	Piedibus	Lecco
France	Plans de mobilité des scolaires	Taverny,
	Plans de déplacements des scolaires	Tremblay
Lithuania	BUSTRIP project, Kaunas school travel plan	Kaunas

to support the shift away from car transport, improve road safety and also bring ancillary benefits to the rest of the population as their use is not restricted to educational travel.

- Car free action days or weeks — For example car free action days or weeks as part of demonstration projects in Limburg (Belgium), and Surrey (the United Kingdom) show how initiatives can be put in place at regional level to successfully reduce car use. This scheme motivated a large number of parents and children to change their travel behaviour and was popular amongst parents. In some schools the initiative reduced car use by between 6 % and 16 % with levels as high as 42 % in some cases (Cairns *et al.,* 2004b from Wilhelm, 2003).

- Improvements to public transport — Improving the frequency, capacity and affordability of buses in a local area may encourage school children to use public transport. This is important, especially as in the United Kingdom 60 % or more secondary school children use the bus to get to school where distance exceeds 3 km. If improvements were made to the reliability of the services and additional bus routes were installed this percentage may rise, especially for secondary school children where bus use appears to be the preferred choice. Care is needed to ensure that there is a genuine shift away from cars as the increase in the numbers of children travelling by bus may be a result of a shift away from walking and cycling, which may be less desirable from a physical activity perspective.

When considering actions to manage educational transport demand, it is useful to consider factors which can influence the effectiveness of a policy.

For example the age of a child can significantly affect the mode of transport that they use to travel to school. Policies may need to be age specific in order to prove effective. Information in the previous sections shows that despite secondary school children travelling further distances to school, they are able to do so without being heavily dependent upon a car, whereas primary school children even in relatively short distances between one and two miles are more likely to be taken to school by car. The case study in Box 6 looks at how age can determine how both primary and secondary school children travel to school.

Educational institutions

A further solution is to look at individual institutions and focus on feasible measures which are most appropriate to the behaviour of the children/students at a school or institution. For example:

- Walking buses — One example has already been discussed (Piedibus in Lecco, Italy) but the schemes' effectiveness has been seen across Europe and has been used in other countries such as France (see Box 7).
- Bike to school initiatives — The Ministere de l'Equipement et des Transports in Belgium highlight the advantages of using a bike especially for journeys less than 5 km. Advantages include being relatively quick, flexible, easy to park, sustainable and a good source of exercise. Cycle proficiency and road safety training can be offered by schools, together with provision of cycle parking facilities and other necessary facilities.
- Providing better storage in the form of desks and lockers for children to store sports equipment, text books etc. — This is in order for children to reduce their load when commuting to and from school and thus reducing the need for parents to assist them by transporting them to and from school by car.
- Car Sharing/ car-pooling schemes — The University of Catalonia focused on promoting car-sharing rather than encouraging cycling or walking as students were unlikely to change their behaviour enough to change modes completely.
- School Travel Plans — In some countries such as the United Kingdom, schools have implemented School Travel Plans which aim to combine a package of measures such as increased education of road safety, travel awareness, installation of cycle lanes, a walking-bus scheme or a car-sharing program. Box 8 provides a brief introduction to School Travel Plans.

5 Conclusions and outlook

To tackle the challenge of CO_2 and transport, a detailed analysis of sectors of economic activities outside the transport sector is needed. Decisions made in those sectors influence the carbon footprint of the transport sector as they are often taken without considering the consequences on transport demand and greenhouse gas emissions.

This study is an initial attempt to understand the key sectors and factors which impact transport demand, and try to identify measures that can be taken to manage demand. It is meant to facilitate the inclusion of reducing transport growth by demand management into the policy discussions on the development towards a sustainable transport system.

Based on a literature review, some key factors affecting demand were identified including socio-demographic changes, economic globalisation, physical changes to urban form/land use, organisational changes at workplaces and schools, socio-cultural changes and technological developments. Key external sectors consisted of retail, leisure/tourism, business, education, and industry. Strong links between these external factors/sectors and transport demand were observed, suggesting the importance for policies to target the non-transport sectors to manage transport demand.

There is a need to tackle climate change through an analysis of transport demand, but there are strong links between different systems. These links are sometimes easy to distinguish, for example in terms of how school policies affect travel behaviour, and how food consumption is directly linked to freight transport, but the link between transport demand and other sectors can be less clear cut, for example the relation between trends in tourism and business models to the aviation infrastructure.

In order to focus efforts on a few issues of particular importance the study took a case study based approach. From the matrix of factors and sectors previously described, nine topics were identified as case study candidates, ranging from the effects of E-commerce on shopping journeys, to the demands of an ageing population on leisure trips.

A set of criteria, consisting of CO_2 reduction potential, EU policy influence, cost effectiveness and political/social acceptability was then used to select the three following case studies:

- effects of food production and consumption on shopping journeys and freight traffic;
- the increasing use of short-haul air travel for business and leisure travel;
- effects of education based travel on transport demand.

Each case study examined the mechanisms by which the sector in question affects transport, recent trends, interactions with other sectors, key influencing factors and possible actions by actor.

5.1 Key findings from the case studies: Ways forward to tackle transport demand

The examination of the three detailed case studies revealed the complex interactions between the various factors and external sectors, and the mechanisms by which transport demand is affected. Some actions that can be taken by the various stakeholders to help manage transport demand were also identified. A short summary of findings from each case study is given below.

Food production and consumption sectors

Transport was highlighted as an important element of the logistical chain from 'farm to fork', with the potential to influence emissions throughout the whole process of producing and consuming food. A wide range of factors, including purchasing power, perception of fashionable/healthy food, availability of foodstuff domestically, product expiration date, marketing, convenience and technological developments were identified as influencing transport demand.

To implement the notion of sustainable production and consumption, a few key actions were identified as important. ***Individual consumer and producer groups and governments*** can further promote food labelling to show its impact on greenhouse gas emissions and to provide consumer information regarding the sources of various food products. ***Manufacturers*** have three basic options for production: use inputs from nearer subcontractors,

improve existing transportation vehicles, or shift to more environmentally sound freight shipment vehicles. ***Retailers*** can contribute to the food carbon footprint reduction by promoting local brands and produces, marketing seasonal products, developing smart logistics and actively supporting government interventions to reduce market barriers to sustainable behaviour. ***Shoppers and consumers*** must be encouraged to take fewer shopping trips or to combine trips or journeys, walk and cycle to food retail centres, use local shops, or purchase local or seasonal produce. Though it is a common believe that consumer choices are hard to influence, consumers can be encouraged to make choices that can reduce food kilometres. ***Governments*** need to modify spatial planning policies to help make food shopping more convenient and associated journeys shorter. ***European policy*** can further influence food consumption through harmonised carbon-based taxation, promoting policies aimed at preventing or reducing the impact of packaging and waste (e.g. Packaging and Packaging Waste Directive 94/62/EC) and encouraging effective labelling schemes.

Short-haul air travel for business and leisure

Air travel is still not an everyday activity, at least not for most people, however the projections of air passenger growth are higher than for other transport modes, and emissions from aviation are growing faster than for other transport modes. Both the business and leisure sectors are increasing their dependence on air travel. Businesses increasingly locate in close proximity to airports for better accessibility to other economic centres within and beyond Europe. Airports have developed from simply being transport hubs to incorporate retail, conference/meeting and accommodation facilities. The increased use of aviation for leisure trips is driven by tourism strategies that favour aviation, and new forms of leisure trips such as 'city breaks', stag/hen parties in Eastern European capitals, and workers flying back to meet their family over holiday seasons. The key factors that influence air travel demand include disposable income, ticket prices, enlargement of the EU, planning policies that favour regional airport development, availability of alternative modes and image/status of flying.

Actions can be taken at several levels to manage the increasing demand for air transport. ***European policy*** can, through the EU-ETS and other pricing mechanisms, aim to internalise the external costs of aviation. Air traffic management can be streamlined through the Single European Sky initiative. Alternative modes, such as rail, can be better provided and coordinated. Information on the carbon footprint of journeys can also be provided to consumers. ***Local and regional bodies*** can develop alternative economic development strategies, such as promoting local tourism, and utilising resources currently spent on air facilities to promote growth in other sectors. ***Businesses*** can invest in alternative technologies such as teleconferencing, to reduce the need to travel physically. ***The aviation industry*** can increase operational efficiency and develop new technologies to increase the fuel efficiency of aircraft.

Education based travel effects on transport demand

Trends across Europe indicate an increase in journeys to school by car, which is linked to negative consequences such as increased transport emissions, reduced road safety, and growing child obesity. The distance to school, which is also linked to the issues of school choice and school closures, was seen as a key factor affecting how children travel to school. Other factors included concerns over children's safety and security, concern for the health of children, adults' travel behaviours, household income, and the cost of transport.

There are various actors and stakeholders that can help to facilitate and benefit from an education based travel shift from carbon-based modes to alternative modes of transportation. National governments, local and regional bodies, educational institutions and parents must work together to formulate the actions that are effective in reducing transport demand by car.

Local and national governments could play a significant role by supporting a denser network of primary schools and by supporting the provision of more aggregated schools with sustainable transport infrastructure for walking and cycling in such a way that children would feel safe on the road. Car free action days or weeks have already been successful in reducing car use on a regional level. Improvement of public transportation is also key to its increased usage by children and educational institutions. Initiatives and actions of ***educational institutions*** play a significant role already. School travel plans, walking buses and car pooling schemes have all been implemented to address the issues of traffic congestion, child safety and health. Another measure that could have an impact may be the adjustment of school working hours, and the provision of children with lockers suited to store sports equipment or books.

5.2 Main overall findings: focus on policy review and impact assessment

The detailed case studies have highlighted the importance of systematically understanding the complex ways in which external factors and sectors affect transport demand. A few common issues were identified, which are significant in meeting the challenge of managing demand and creating a more sustainable transport sector. These are summarised in the section below.

Issues to consider in ensuring effectiveness of policies

First, policies are most effective when formulated under realistic assumptions regarding their effects on transport demand. It must be appreciated that rail transport cannot substitute all air travel, not everyone would wish to switch to locally-produced food, and that not all parents would support their children walking to school.

Second, the long term and wider implications of non-transport policies need to be considered. For example, the discussion about food production and consumption is closely linked with how the entire global trade system is structured. The development of aviation facilities to cater for new demand by businesses and leisure travellers is likely to result in air dependence in the long run, and the way in which children travel to school is likely to affect their travel choices later on in their lives.

Third, intervention is best taken place at the optimal level of governance. Although supra-national institutions such as the EU can often play a large role in setting up frameworks that encourage transport demand reduction, actors at a local level must also be empowered to bring about change, such as in the case with school travel plans.

Issues to consider in ensuring public acceptability of policies

To improve the public acceptability of policies, the following issues are thought to be of importance.

First, the ancillary benefits of managing transport demand should be highlighted. For example, promoting local and regional tourism may have the extended positive effects of more engagement in sports and physical activity, a better appreciation of the local environment, and a boost to the local economy.

Second, revenue from increased taxes (e.g. to internalise the external costs of transport) is by definition not pre-empted for a specific purpose. However by political decisions they can of course be channelled wherever appropriate to projects that positively impact the environment and/or society. For example, revenues from a carbon-based tax can be used to cover costs for cycling and walking infrastructure.

Third, marketing of policy is thought to be important. Although initial support for schemes that increase taxes may be low, people may become more favourable if they are given adequate information about what would happen without the tax increase.

Issues to consider in ensuring cost effectiveness of measures

To ensure the cost effectiveness of measures to manage transport demand, a crucial consideration is thought to be the timing of implementation. In many cases, it is easier both politically and financially, to solve a problem before it becomes a large issue. In the case of air travel, it was mentioned that the key challenge is to manage demand before it occurs. Similarly, the car dependence of children can be tackled in Eastern Europe before motorisation levels reach those observed in Western Europe.

Issues to consider in ensuring consistency of approach

To ensure a consistent approach to managing transport demand, policies can be harmonised, wherever appropriate, at the EU and/or sub-regional level. For example, a higher tax on aviation fuel in one country is likely to lead to airlines simply relocating their fuelling stations to other countries in the vicinity. A similar issue may be observed in the road sector, where countries such as Luxembourg are favoured by motorists as a place to fill up their tank due to the lower taxes there.

Issues to ensure proper assessment of transport effects

On the EU level, integration of transport planning into impact assessments in local, regional and urban development plans should be once again emphasised.

A review of the effectiveness of existing Impact Assessment tools taking transport effects into account may give a further indication of effective policy instruments. This should take place on

a European level like the ex-ante evaluation and Impact Assessment for new initiatives with budgetary implications for the Community Budget (EC, 2006d) as well as national applications of the Environmental Impact Assessment and the Strategic Environmental Assessment. For the latter, a review of national implementation is ongoing.

Furthermore, there has to be further research into whether Transport Impact Assessments and Policy Impact Assessments could be a key instrument for achieving more sustainable transport strategies and managing transport demand.

Integration of carbon emission consequences through carbon management must be one of the issues analyzed in the design and assessment of national and European strategies. The discourse in the policy field of sustainable consumption and production is crucial for developing an overall strategy (EEA, 2008c).

5.3 Outlook: Future challenges to tackling transport demand

This study was an initial attempt to understand the main external sectors and factors which impact transport demand. Although it has succeeded in highlighting the fundamental issues surrounding transport demand, it has also found a great knowledge gap on specific mechanisms by which the various sectors and factors influence the transport sector. This reflects the general lack of consideration by stakeholders outside of the transport sector of their actions on transport demand.

Many of the literature sources consulted in the study pointed out the difficulties in quantifying the influences of external sectors and factors on transport demand, especially when more than one force was at work at the same time.

The lack of comparable and reliable data was also found to be a problem. Data on slow modes, such as cycling and walking were particularly found to be scarce.

Knowledge of the interactions between the various sectors and actors in the economy was also found to be limited, perhaps reflecting the segmented nature of many political and academic institutions. Coordination is needed between all policies using natural resources and affecting the environment. These include economic, fiscal, agricultural, energy, trade and transport policies. Establishing coherent goals regarding the quantities used, or regarding the environmental impacts generated is one way to approach the issue (EC, 2004).

Furthermore, there was a scarcity of research around socio-cultural changes and their effects on transport, These should play a more significant role in understanding and managing how and why people travel in the future (EEA, 2007b).

Reducing this knowledge gap is thought to be beneficial in achieving the targets set to reduce transport's contribution to climate change and other environmental effects. Funding for further research is welcomed, so that the conceptual framework developed for this study can be further expanded to cover a larger set of factors and sectors. Discussion on the policy instruments of non-transport sectors to tackle the problems of climate change and the environment is needed on all levels of governance.

It is hoped that the findings from this study will lead to a new way of thinking around transport demand, so that the transport and other indirect environmental consequences are acknowledged in the strategic decisions made by all sectors in the economy. This may then lead to the integration of transport/travel strategies into the decision making and planning process of all sectors, which would assist in creating a more sustainable transport sector.

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Abbreviations

ACEA	European Automobile Manufacturers Association
ACI	Airport Council International
CCE	Central and Eastern Europe
C4S	Centre for Sustainability at TRL Ltd.
DEFRA	Department for Environment, Food and Rural Affairs
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EEA	European Environment Agency
ESRA	European Sustainability Reporting Association
EU	European Union
EU-10	Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia
EU-15	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom
EU-25	EU-10 and EU-15
EU-27	EU 25 and Bulgaria and Romania
ETS	Emissions Trading Scheme
GHG	Greenhouse gas
GDP	Gross Domestic Product
HGV	Heavy Good Vehicle
IATA	International Air Transport Association
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
INS	Institut National de la Statistique
ITF	International Transport Forum
ITRD	International Transport Research Documentation
JAM	Japan Automobile Manufacturers Association
KAMA	Korean Automobile Manufacturers Association
MOST	Mobility Management Strategies for the Next Decade
NTS	National Travel Surveys
OECD	Organisation for Economic Cooperation and Development
SACTRA	Standing Advisory Committee on Trunk Roads
TGV	Train a Grande Vitesse (Train of Great Speeds)
TRL	Transport Research Laboratory
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCC	United Nations Framework Convention on Climate Change
UPC	Polytechnic University of Catalonia
VOC	Volatile Organic Compounds
WTO	World Trade Organisation
WTTC	World Travel and Tourism Council

Annex A: Literature inventory (summarised)

Authors	Year	Title	Dimension				
			Regional scope	Passenger or freight	Mode	External sector	Factors
Banister, D.	2005	Unsustainable Transport: City Transport in the New Century. Taylor & Francis	UK	Passenger	Land	Land use	Spatial socio-economic
Banister, D (ed); Hall, P	1995	Transport and urban development, Chapter 5: A European perspective on the spatial links between land use, development and transport	EU	Passenger	Land	Land use	Spatial socio-economic
Banister, D and Hickman, R	2003	Transport and city competitiveness	Global	Both	All	Business	Economic
Becker, J, Brummelman, A, and Demkes, R	2002	The impact of e-commerce on transport in Europe	EU	Freight	Land	ICT, e-commerce	Economic
Bennathan, E, F. Julie and L.S. Thompson	1992	What determines demand for freight transport?	Global	Freight	Road, Rail	NA	Economic
Bonsall, P.W.; Polydoropoulou, A.; Baker, M.; Ben-Akiva M.; Mindali, O.; Salomon, I.	2004	Factors Affecting the Impact of E-economy on Transport	Global	Both	Land	ICT	Behaviour, technology
Camagni, R, Gibellib MC and Rigamonti, P	2001	Urban mobility and urban form: the social and environmental costs of different patterns of urban expansion	Milan	Passenger	Land	Land use	spatial
CfIT-Commission for Integrated Transport	2007	Transport and Climate Change	Global	Both	All	Various	Behaviour
Dargay, J.M. and Hanley, M	2001	The Determinants of the Demand for International Air Travel to and from the UK	UK/Global	Passenger	Air	NA	Economic
Dargay J. M. and Hanly M	2003	The impact of land use patterns on travel behaviour	UK	Passenger	Land	Land use	Economic, Socio-demographic
Dargay, M. and Pirotte	2000	The main determinants of the demand for public transport: a comparative analysis of England and France using shrinkage estimators	EU	Passenger	Public	NA	Economic
De Jong and Van de Riet	2004	Drivers of Demand for Passenger Transport Worldwide	Global	Passenger	Public	All	Behaviour
De Jong and Van de Riet	2004	Drivers of Freight Transport Demand Worldwide	Global	Freight	All	Industry	Economic, structual
Eads, G	2004	Worldwide Demand for Mobility and Petroleum (Presentation)	Global	Both	All	Energy, Industry	Economic, spatial, demographic
Ellwanger, G and Georger, O	2001	The impact of social and demographic changes on transport demand in Europe in the year 2030	EU	Passenger	Rail	NA	Socio-demographic
Glaeser, Edward	2007	The Economic Approach to Cities	Global	Passenger	Land	Housing, Land use	Economic
Grantham, G	2007	What's Space Got To Do With It? Distance And Agricultural Productivity Before The Railway Age	EU	Both	All	Agriculture	Spatial, economic
Halatsis, A, Black, I and Shinakis, M	2000	Advanced road transport electronic management information systems: the ARTEMIS project	EU	Freight	Land	ICT, Retail, Industry	Information

Authors	Year	Title	Dimension				
			Regional scope	Passenger or freight	Mode	External sector	Factors
Hanssen, JU	2000	Transportation impacts of office relocation A case study from Oslo	Oslo	Passenger	Road, Rail	Business	Spatial, Behavioural
Hiferink, P	2003	The Correlation between freight transport and economic growth	EU	Freight	All	Industry, Trade	Economic, Spatial, Political
Hjorthol, RJ	2000	The relation between daily travel and use of the home computer	Norway	Passenger	Land	ICT	Technology, behaviour
Holz-Rau, C *et al.*	2000	Quantification of Traffic Generation and its Environmental Impacts through Decisions, Frameworks und Measures indirectly influencing Transportation	Germany/ EU	Both	Land	Various including Housing	spatial, economic, social
ISIS *et al.*	2003	Achieving Sustainable Transport and Land Use with Integrated Policies	EU	Both	Land	Land use	Spatial
ISIS *et al.*	2000	Impacts of Megatrends on Transport and Land Use in Europe	EU	Both	All	Various	Spatial, socio-demographic, economic, technical, structural
Jahanshahi K.	2007	Comparative study of the interaction between land use and transport	N. America	Passenger	Land	Land use	Behaviour
Jin, Y and Davies, A	2000	Updating input-output coefficients for freight demand modelling: example of EUNET Trans-Pennine data	UK/EU	Freight	All?	Industry	Spatial, economic, demographic
Jin, Y *et al.*	2006	Economy, logistics and freight demand forecasting in Great Britain	UK	Freight	Land	Industry	Economic, Spatial, Behavioural
Joly, Masson and Petiot	2004	The determinants of urban public transport: an international comparison and econometric analysis	Global	Passenger	Public	NA	Economic, spatial, demographic
Leinbach T. and C. Capineri (ed.)	2007	Globalised Freight Transport: Intermodality, e-commerce, Logistics and Sustainability (Transport Economics, Management and Policy.) Edward Elgar Publishing	Global	Freight	All	Industry	socio-demographic, economic, technological
Lenz B	2005	Anytime, anywhere and always on the move? – the potential of ICT to shape travel behaviour	Global	Both	All	ICT	socio-demographic, economic, technological
Lyons, G *et al.*	2001	Determinants of travel demand — exploring the future of society and lifestyles in the UK	UK	Passenger	All	NA	Lifestyles
Keith J. Mason	2005	Observations of fundamental changes in the demand for aviation services, Journal of Air Transport Management, Volume 11, Issue 1, Pages 19-25	Global?	Both	Air	NA	
May, A.D.; Muir H.; Shepherd, S.P.; Wagner P.	2007	Assessing the impact of new technologies in urban areas	UK?	Unknown	Unknown	Unknown	Technology
McKinnon, A	2007	CO_2 Emissions from Freight Transport in the UK	Uk	Freight	Road, Rail	Industry	Economic, technology, behaviour
ME&P *et al.*	2002	SCENES Final Report	EU	Both	Land	Various	Economic, socio-demographic, structural
Meersman, H and Van De Voorde, E	2005	Decoupling of freight transport and economic activity: realism or utopia?	EU	Freight	All	Industry, ICT	Technology, economic
Miguel Ángel Tarancón Morána and Pablo del Río González	2007	Structural factors affecting land-transport CO_2 emissions: A European comparison	EU	Both	All	Various	Economic structure

Authors	Year	Title	Dimension				
			Regional scope	Passenger or freight	Mode	External sector	Factors
Nijkamp, P	1997	A meta-approach to investigate the variance in transport cost elasticities: a cross-national European comparison	EU	Both	All	NA	Economic
OECD	2003	Managing the Fundamental Drivers of Transport Demand	Global	Both	All	Various	socio-demographic, Economic, Technology
Oum, Waters and Yong	1990	A survey of recent estimates of price elasticities of demand for transport	Global	Both	All	NA	Economic
Paulley, N	2000	The relationship between urban form and transport supply and demand	EU	Passenger	Land	Land use	Spatial
Priebs, A; Dittrich-wesbuer, A; Handy, S; Sessa, C; Banister, D	2004	Transport and spatial policies – the role of regulatory and fiscal incentives	Global	Passenger	Land	Land use	Structural, Political, Socio-economic
Puwein, W	2000	Effects of EU Enlargement on Transport in Austria	Austria/EU	Both	All	Tourism, Industry	Economic, structural
Runhaar, H and Van Der Heijden, R	2005	Public policy intervention in freight transport costs: effects on printed media logistics in the Netherlands	Netherlands	Freight	Land	Industry	Cost
Scheiner and Birgit	2002	Lifestyles, choice of housing location and daily mobility. Conceptual framework, methods and preliminary results of the interdisciplinary research project 'StadtLeben'	Global	Passenger	Land	Housing	spatial, behavioural, socio-demographic,
Schwanen, T; Dijst, M, Dieleman, FM	2001	Leisure trips of senior citizens: determinants of modal choice	Netherlands	Passenger	Land	NA	socio-demographic,
Shen, J; Sakata, Y; Hashimoto, Y	2005	Is Individual Environmental Consciousness One of the Determinants in Transport Mode Choice?	Japan	Passenger	Land	NA	Culture
Siu Y.L.; Rees P.; Fowkes, A.S.; Nash, C.A.; May, A.D.	2006	Demographic change and future transport demand: An analysis of the British Situation 1989–2006	UK	Unknown	Unknown	NA	Demographics
Sivakumar, A and Bhat, CR	2006	A comprehensive, unified, framework for analysing spatial location choice	Global	Passenger	All	Various	Spatial
Sivakumar A and Bhat C	2006	A comprehensive, unified, framework for analyzing spatial location choice	Global?	Passenger	Land	Land use	Spatial, Behaviour
Tight, MR, Delle Site, P and Meyer-Rühle, O	2004	Decoupling transport from economic growth: Towards transport sustainability in Europe	EU	Both	All	NA	NA
TRL	2001	Land use and transport planning update	Global	Both	All	Various	Spatial
TRL	2004	The Demand for Public Transport	UK/EU	Passenger	Public	All	All
TRL	2007	Transport Demand and Modal Shift Update	Global	Passenger	Land	NA	Various
Tyndall Centre for Climate Change Research	2004	How can we reduce carbon emissions from transport?	Global	Passenger	Road, Rail	Housing	Behaviour
UK Government	2006	Climate Change Programme	UK				
Van De Coeveringa, P and Schwanen, T	2004	Re-evaluating the impact of urban form on travel patterns in Europe and North-America	EU/N. America	Both	All	Land use	Lifestyles

Authors	Year	Title	Dimension				
			Regional scope	Passenger or freight	Mode	External sector	Factors
Verron, H *et al.*	2005	Determining factors in traffic growth – Developments, causes and possible future directions	Germany/ EU	Both	All	Various	economic, social, spatial, lifestyle
Verny, J	2007	The importance of decoupling between freight transport and economic growth	France/EU	Freight	All	Industry	Spatial, economic structure
Vickerman, R	2003	Transport in an Integrating Europe: Sustainable Development and Cohesion	EU	Both	All	Industry	Economic
Wardman, M.R.	2006	Demand for Rail Travel and the Effects of External Factors	UK	Passenger	Rail	NA	socio-demographic,
Wardman, M.R.; Whelan, G.A.; Lythgoe, W.F.	2007	Examining the influence of socio-demographic change on rail demand	UK	Passenger	Rail	NA	socio-demographic, economic
WBCSD	2004	Mobility 2030: Meeting the challenges to sustainability	Global	Both	All	Energy, Industry	Economic, technological, socio-demographic,
Whitelegg, J and Low, N	2003	Managing transport demand in European countries. In: Making urban transport sustainable	EU	Both	All	NA	Culture, Psychology
Williams I	2005	Travel demand – the influence on commuter distances of labour supply/demand imbalances	UK	Passenger	Land	Land use	Economic, socio-demographic,
EC sources							
EC	2001	White Paper on transport	EU				
EC	2006	Keep Europe moving – Sustainable mobility for our continent Mid-term review of the European Commission's 2001 Transport White Paper	EU				
EC	2007	Commission Staff Working Document – accompanying Green Paper	EU				
EC	2007	Towards a new culture for urban mobility, green paper	EU				
EC DG TREN	2006	Analysis of the contribution of transport policies to the competitiveness of the EU economy and comparison with the United States	EU/USA	Both	All		Various
EC DG TREN	2003	Prediction of e-Economy impacts on Transport (POET): http://www.poet-eu.org/default.asp	EU	Both	All		
EC FP5	2008	PROPOLIS Final report: Planning and Research of Policies for Land Use and Transport for Increasing Urban Sustainability: http://www.ltcon.fi/propolis	EU	Both	All	Land use	All
EEA	2007	TERM 2006 – indicators tracking transport and the environment in the European Union	EU				
Papi, J [European Union Road Federation, Brussels, Belgium]	2002	The European Commission's new common transport policy	EU				
Rees, H [European Commission]	2003	Re-thinking the objectives of EU infrastructure charging policy	EU				
Suchorzewski, W [Technol Univ, Warsaw, Poland]	2003	Implementation issues in transition economies	EU				
Extra Sources for Consideration							

Authors	Year	Title	Dimension				
			Regional scope	Passenger or freight	Mode	External sector	Factors
Bellak, C; Leibrecht, M; Damijan, JP	2007	Infrastructure endowment and corporate income taxes as determinants of Foreign Direct Investment in Central – and Eastern European Countries	EU-East				
DfT	2005	Focus on Personal Travel: http://www.dft.gov.uk/162259/162469/221412/221531/224097/224100/coll_focusonpersonaltravel2005ed/focusonpersonaltravel2005edition	UK	Passenger			
Gourdon, J	2006	Explaining Trade Flows: Traditional and New Determinants of Trade Patterns	Global				
Ibanez, J.N.; Fowkes, A.S.	2005	Factors determining freight transport demand: a comparative study of estimation methodologies	Unknown	Freight			
Lafourcade, M and Thisse, JF	2008	New economic geography: A guide to transport analysis	Global				
Nijkamp, P	2000	Different perspectives on the global development of transport	Global				
Mackett, R *et al.*	2005	The therapeutic value of children's everyday travel, Transportation Research	Unknown	Passenger	Road	School travel	Social, health
Martínez-Zarzoso I. & L García-Menéndez & C Suárez-Burguet	2003	Impact of Transport Costs on International Trade: The Case of Spanish Ceramic Exports	Spain				
Riou, S.	2000	How Growth And Location Are Sensitive To Transport And Telecommunication Infrastructures: A Simple Theoretical Approach					
Rossi *et al.*	2004	Lotta alla sedentarietà: a scuola con il Piedibus: http://www.piedibus.it/upl/biblioteca/1116342020_piedibus %20epidemiologia %20 %20e %20prevenzione.pdf	Italy	Passenger	Walking	School, health	Socio–economic
Rye T	2002	Company management of staff's travel choices in the UK (p175-200), *Managing Commuters' Behaviour – a New Role for Companies – Report of the 121st Round Table on Transport*	UK				
Wardman, M.R.; Whelan, G.A.; Preston J.M.	2007	Strategic Forecasting of Rail Passenger Demand in Great Britain	UK				
Whelan, G.A.; Wardman, M.R.; Daly, A.J.	2000	Is There a Limit to Car Ownership Growth? An Exploration of Household Saturation Levels Using Two Novel Approaches	UK				

Annex B: Short case studies (overview)

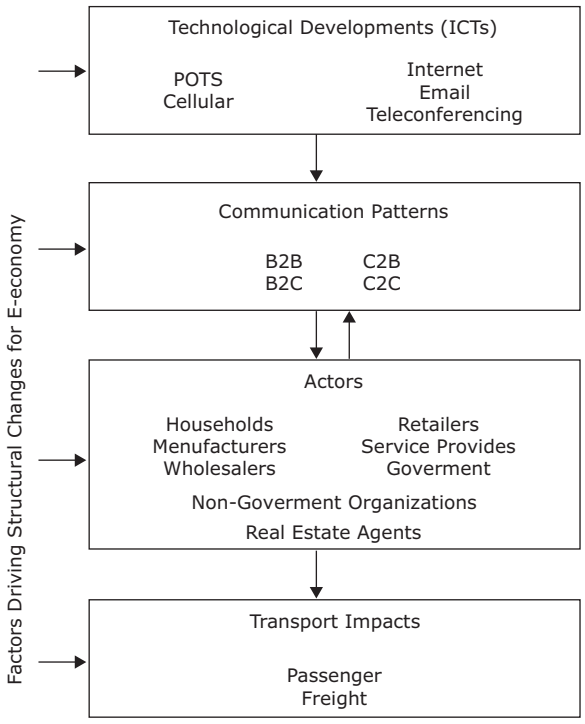
Table B.1 Shopping — the effects of e-commerce on shopping journeys

Mode of Transport:	Criteria	Score	
Freight (production source to outlet)	Carbon reduction potential	Short	Low
Passenger (shopping)		Medium	Medium
Sectors:		Long	Medium
Trade, Retail	EU policy influence	Weak	
Factors:	Cost effectiveness	High	
Economic, Technological, Cultural	Political/social acceptability	Medium	

How does it affect transport demand?

The rise of information and communication technologies (ICT) continues to change the way we purchase goods and services. The overall effect of e-commerce on transport depends mainly on whether delivery by the provider is more efficient than travel by consumers to shops.

Figure B.1 Influencing factors for the e-economy



Source: Polydoropoulou *et al.* (2003).

An EU-funded study showed that e-commerce has a two-sided effect on transport. On the one hand, customers become much more demanding – due to the new technology, putting pressure on delivery times and increasing delivery frequency (of smaller order sizes). On the other hand, ICT enables greater optimisation of resources throughout the logistical chain (Polydoropoulou *et al*, 2003). Additionally, depending on the product ICT can increase or reduce the transport demand.

What can be done about it?

The challenge is to ensure that new ICT improves the efficiency of the logistical chain faster than the added pressure on deliveries. Repetitive online shopping for frequently needed goods, e.g. household goods, consumables and books, may have a large impact on transport demand (Golob and Regan, 2001).

Measures to consolidate deliveries for these goods, particularly across various providers and households, would help to reduce travel demand.

Table B.2: Shopping/freight — effects of food production/consumption on shopping and freight traffic

Mode of Transport:	Criteria	Score	
Freight (production source to outlet)	Carbon reduction potential	Short	Low
Passenger (shopping)		Medium	Medium
Sectors:		Long	Medium
Agriculture, Production,Trade/Retail, Consumer	EU policy influence	Weak	
Factors:	Cost effectiveness	High	
Economic, Cultural, Social, Spatial	Political/social acceptability	Medium	

How does it affect transport demand?

Food consumption affects transport demand through the movement of goods from the location of production to the final retailing outlet, and from the outlet to consumers' homes. For some food types, such as mineral water, transport constitutes a large proportion of the overall carbon impact of the product lifecycle. Air-transported goods represent a very low proportion of total food consumption, but this is expected to grow significantly in the coming years.

What can be done about it?

Efforts are already being made by some member states to provide consumer information (labelling) regarding the source of various food products (Carbon Trust, 2008). Some food retailers are already active in placing information on food sources, using easily identifiable 'traffic light' type labels. However, such practices are still not mandatory under EU regulations (EC, 2008) for all food products.The EU may further influence food consumption – through harmonised carbon based taxation covering the transport sector. Some measures, such as combined journeys, may be a cost-effective way of reducing shopping journeys. Food is a sensitive area for the public; therefore the challenge is to preserve consumer choice whilst reducing the carbon footprint.

How does it affect transport demand?

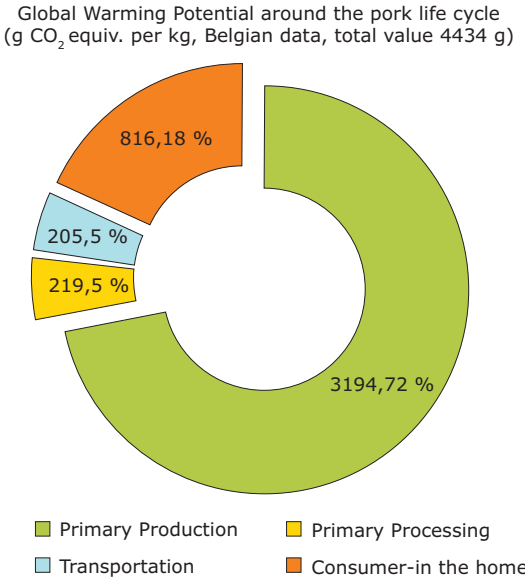
Aviation is one of the fastest growing sources of greenhouse gases in the transport sector. Intra-European flights (including domestic and to non EU countries) account for roughly 75 % of EU air passengers (Eurostat, 2004). Emissions from aircraft have larger impacts on climate change than other

Figure B.2a Energy life cycle for apples

Local fruit (Germany)		Imported fruit (ex New Zealand)	
Life cycle stage	**Primary energy requirement MJ / kg apples**	**Life cycle stage**	**Primary energy requirement MJ / kg apples**
Cultivation	2.8	Cultivation	2.1
Transfer to packer and cooling	0.16	Transfer to packer and cooling	0.23
Packaging	0.65	Packaging	0.65
Storage	0.81	Storage	2.8
Transport in Germany	0.33	Transport in Germany	0.54
Consumer Shopping	1.2	Consumer Shopping	1.2

Source: Blanke & Burdick, 2005.

Figure B.2b Global warming potential of pork

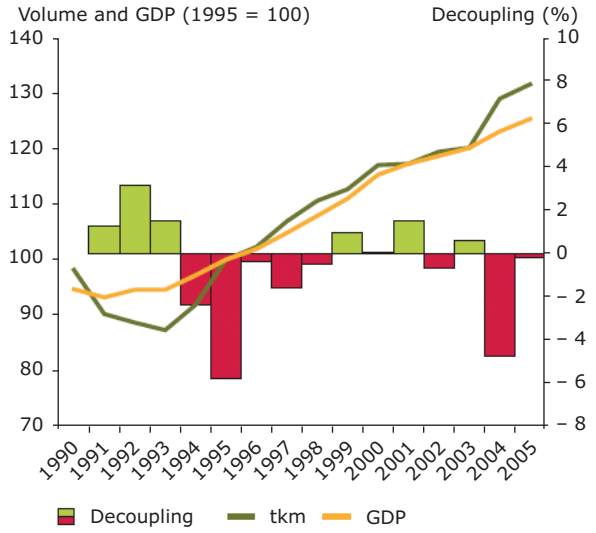


Source: DEFRA (2006a).

Table B.3 Leisure/business — the increasing use of short-haul air travel for business and leisure travel

Mode of Transport:	Criteria	Score	
Passenger (shopping)	Carbon reduction potential	Short	Medium
Sectors:		Medium	High
Leisure (tourism), Business		Long	High
Factors:	EU policy influence	Strong	
Economic, Cultural, Demographic	Cost effectiveness	High	
	Political/social acceptability	Medium	

Figure B.3 Passenger transport demand in Europe is growing faster than GDP (1990–2030)



Source: EC (2007b).

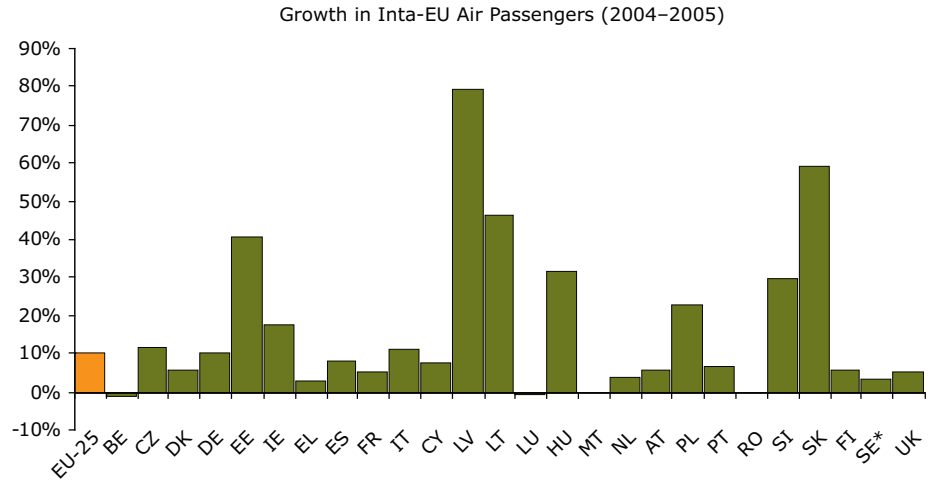
modes of transport, mainly due to the altitude at which they are emitted (IPCC, 1999).

The growth in passenger demand has been driven, amongst other factors, by economic growth and lower fares, as witnessed by the surge in low-cost carriers. Growth is particularly strong in the new accession countries in Central and Eastern Europe.

What can be done about it?

Fiscal measures to internalise the external costs of air travel can be an important element of rationalising demand. Levers include the EUETS, taxation of jet fuels, passenger duties and landing fees. These however, may not be sufficient to guarantee an absolute reduction in demand. Supply-side measures, such as careful planning of aviation infrastructure and development of potential substitutes such as high speed rail and telecommunication, may also help.

Figure B.4 Growth in intra-EU air passengers (2004/2005)



Source: Eurostat (2005).

Table B.4 Leisure — demands of an ageing population on leisure trips

Mode of Transport:	Criteria	Score	
Passenger	Carbon reduction potential	Short	Low
Sectors:		Medium	Medium
Leisure (tourism)		Long	Medium
Factors:	EU policy influence	Medium	
Demographic, Cultural	Cost effectiveness	Medium	
	Political/social acceptability	Medium	

Developing in-country tourism may also play a part in reducing demand, whilst encouraging domestic consumption and growth of the local economy.

How does it affect transport demand?

Europe faces an ageing population. In many member states, one in four people is predicted to be over 65 by the year 2030. The travel behaviour of older people depends on their health, travel needs and preferences (OECD, 2001).

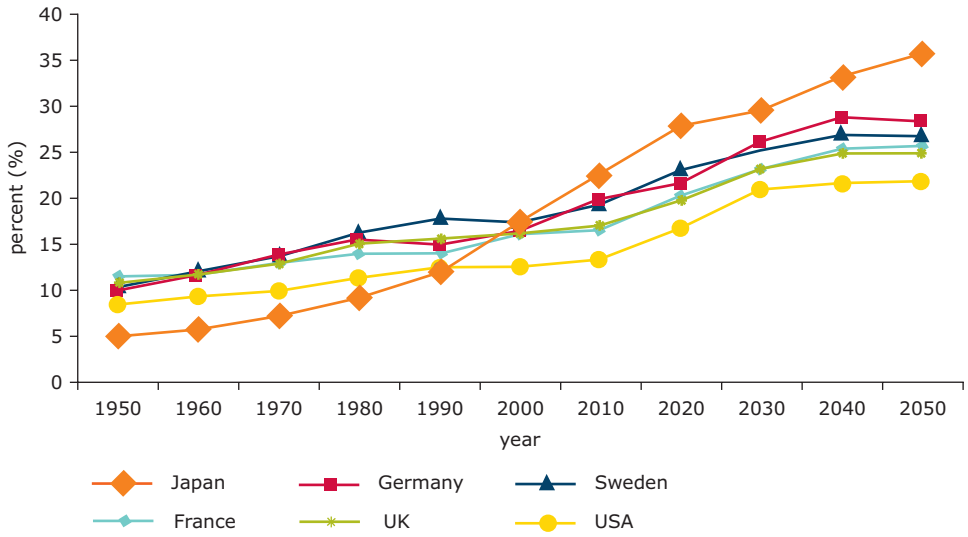
A Dutch study by Schwanen *et al* (2001) shows that older people prefer to travel by car for leisure trips. Owning a car encourages them to use it irrespective of where they live. The residential environment influences the modal choice of senior citizens without a car. Public transport is mostly seen as a substitute for walking and cycling journeys, but not for car journeys. This poses a large challenge for policy-makers, especially as the percentage of licensed drivers over the age of 65 is expected to grow significantly as the current car-oriented working population retires (OECD, 2001).

What can be done about it?

General measures which address excess car travel, including fuel taxation, road pricing and traffic regulations, are likely to affect senior citizens as well. However, in order to maintain their mobility whilst reducing reliance on the car, cities and transport systems will need to be altered to accommodate the special needs of senior citizens. For instance, public transport facilities would need to be made accessible by wheelchairs.

Improving local tourism infrastructure, especially in relation to the accessibility of footpaths and

Figure B.5 Predicted percentage of over 65 year olds in selected countries



Source: Japanese Cabinet Office (2002).

Table B.5 **Freight — changes to industrial structure after EU expansion & their effects on freight traffic**

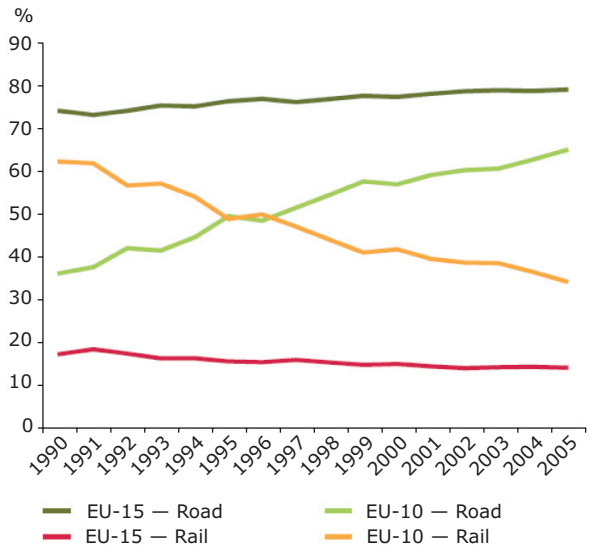
Mode of Transport:	Criteria	Score	
Freight	Carbon reduction potential	Short	Low
Sectors:		Medium	Medium
Industry		Long	High
Factors:	EU policy influence	Strong	
Economic	Cost effectiveness	Medium	
	Political/social acceptability	Medium	

public transport (including by wheelchair) would to some extent provide an alternative to the car, and bring other benefits such as improved safety. This could include traffic calming and car-free city centres.

The use of public transport modes can be encouraged by providing concessionary fares, and organised tours by coach and boat.

Such measures would be effective in reducing environmental effects whilst sustaining a high quality of life for those after retirement.

Figure B.6 **Share of road and rail freight traffic in EU 15 and EU 10 countries**



Source: EEA (2008).

How does it affect transport demand?

The process of regional integration in the EU, combined with globalisation, has continued to increase the division of labour and level of specialisation across EU countries and regions. Whilst a shift away from heavy industry as well as outsourcing transport heavy industries to the developing countries have brought a fall in the weight of goods being transported, increases in trade, regional specialisation and the length and complexity of the logistical chain have grown faster, resulting in the increase of total freight transport volume (see Vickerman, 2003).

This is particularly eminent in the new member states of Central and Eastern Europe (CEE), where the traditional heavy industries and rail-based trade with Russia have now in large been replaced by road-based trade with Western Europe and the CEE countries.

What can be done about it?

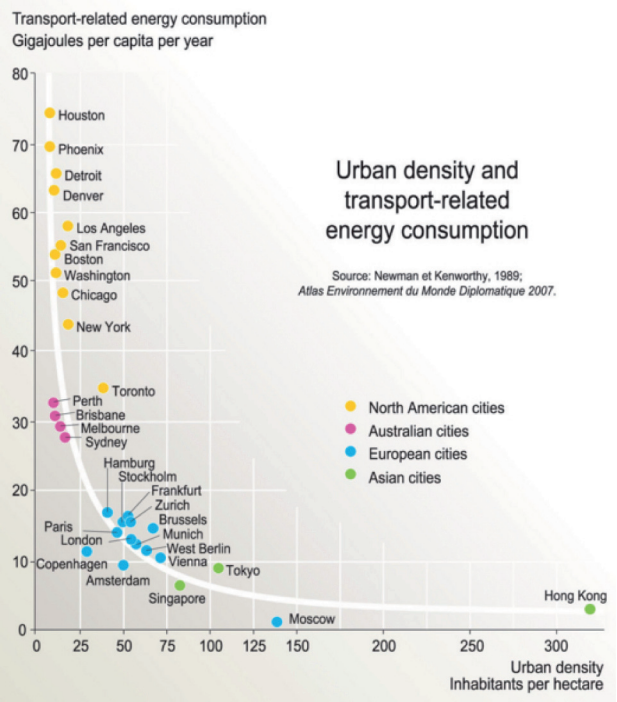
The EU member states can collectively ensure that environmental costs are included in transport prices, which in turn will guide decisions made by firms on where to produce, which product/service to provide, and how to deliver them to end consumers. This may be done through road pricing, fuel taxation and other fiscal measures, ensuring that there are no leakages between Member States.

Such policies would need to be designed to lock in the reductions in CO_2 emissions brought about by technological advancements. This would mitigate an increase in transport volume and distance following on from improvements in fuel efficiency.

Table B.6 Built environment — the relationship between urban form and transport demand

Mode of Transport:	Criteria	Score	
Passenger, freight	Carbon reduction potential	Short	Low
Sectors:		Medium	Medium
Built environment (land use)		Long	High
Factors:	EU policy influence	Medium	
Spatial	Cost effectiveness	High	
	Political/social acceptability	Medium	

Figure B.7 Urban density and transport-related energy consumption



Source: Newman and Kenworthy, 1989.

The integration and improvement of rail systems among different EU regions, inner-sea and inland waterways shipping may counteract some of the growth in road transport, although the magnitude for change depends on the nature of the goods being transported.

How does it affect transport demand?

Transport and urban form are often described as being in a 'chicken or egg' relationship; urban form influences, and is influenced by, the provision of transport infrastructure and services.

Existing research shows that the density of cities and the level of concentration of jobs in the city core and sub-centres are determinants, at least in part, of the type and level of transport activity (Van de Coevering and Schwanen, 2006). Less dense cities (such as those in the United States) are associated with a higher reliance on the car, whereas for European cities with a population of over 750 000, car share is shown to decrease as city size increases (SESAME, 1999).

What can be done about it?

Planning can be used to revitalise inner cities, concentrate new development around present rail systems, discourage further urban sprawl, extend transit systems and build new urban villages around them (Newman and Kenworthy, 1999). These can

Table B.7 Business — influencing commuting journeys by corporate management

Mode of Transport:	Criteria	Score	
Passenger	Carbon reduction potential	Short	Medium
Sectors:		Medium	Medium
Business		Long	High
Factors:	EU policy influence	Medium	
Economic, Spatial, Cultural	Cost effectiveness	High	
	Political/social acceptability	Strong	

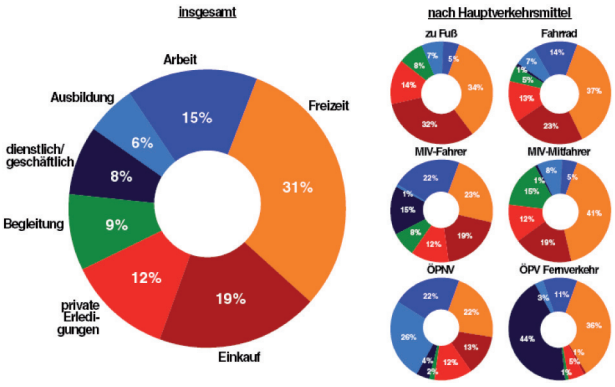
be supplemented by pricing measures, such as the revision of commuter subsidies and road pricing.

Urban planning policies must take into account the historical, social and demographic factors that affect transport demand, as well as the existing transport infrastructure and service provision.

How does it affect transport demand?

The journey to work constitutes a large proportion of the overall demand for passenger transport (roughly 20 % in the United Kingdom, and 29 % in Germany). The car is the dominant mode of choice in many regions (roughly 70 % in the United Kingdom). Improvements in vehicle speed, increased income and lifestyle changes now allow us to live much further away from the workplace, resulting in physically longer (but not necessarily more time consuming) commutes (see Metz, 2008).

Figure B.8 Journey type by mode in Germany



Source: Infas and DIW (2002a).

What can be done about it?

Employers are well placed to influence their employees' travel patterns. Workplace Travel Plans, which are a package of measures aimed at encouraging sustainable travel, e.g. less single occupancy car use, flexible working time – have been shown to be very effective in reducing reliance on the car. A British study by Cairns *et al*. (2004) of 20 workplaces recorded an average 18 % reduction in car use after the adoption of a Workplace Travel Plan.

Such measures can also bring ancillary benefits such as increased health of employees, reduced absenteeism, better productivity, and better corporate image (as a modern, responsible employer).

Governments can help disseminate best practices amongst employers, communicate the financial benefits (e.g. public transport travel compensation schemes, healthier employees, better environmental credentials) and incentivise firms with tax breaks and other fiscal benefits. Non-transport related measures should extend to future business area planning and be linked with transport plans.

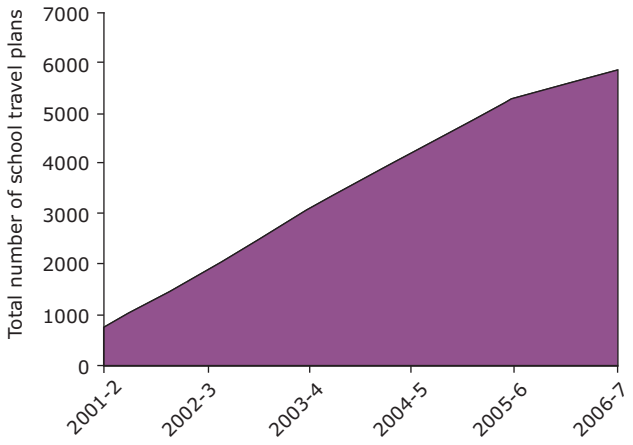
Table B.8 Effects of education based travel on transport demand

Mode of Transport:	Criteria	Score	
Passenger	Carbon reduction potential	Short	Low
Sectors:		Medium	Medium
Education		Long	Medium
Factors:	EU policy influence	Weak	
Social, cultural, spatial	Cost effectiveness	Medium	
	Political/social acceptability	Strong	

How does it affect transport demand?

In many member states, children's journeys to school are increasingly made in their parents' car. Whilst school-related journeys typically constitute a small fraction of overall transport demand, they often take place at the busiest times of day, leading to congestion and subsequently more emissions (see Cairns *et al.*, 2004).

Figure B.9 School travel plans in England



Source: Cairns *et al.* (2004).

What can be done about it?

Experience from countries such as Sweden, the Netherlands and the United Kingdom shows that successful attempts to discourage car use often combine hard measures (such as provision of safe crossings, cycle lanes and traffic calming) with soft measures (such as information for parents, safety training, and tailored promotion).

School buses similar to those in the United States may provide a good alternative to cars in many cases. Supervised group walks and cycling trips (such as the walking bus in Italy and cycling train in the United Kingdom), may also deliver further benefits in the form of increased physical activity and reduced obesity.

School travel plans as seen in the United Kingdom may help combine the efforts of schools, local authorities and parents to overcome reliance on the car. A related policy recommendation is to consider the benefits of local school attendance versus free choice of school.

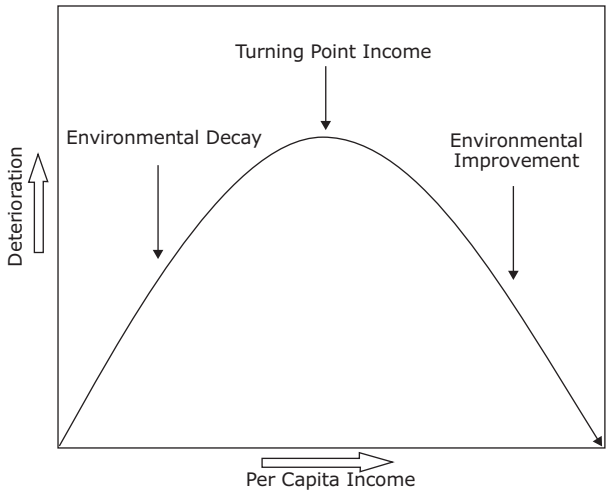
Table B.9 All sectors — changing social values and its effects on transport demand

Mode of Transport:	Criteria	Score	
Passenger	Carbon reduction potential	Short	Low
Sectors:		Medium	Medium
All		Long	High
Factors:	EU policy influence	Weak	
Cultural, Social, Economic	Cost effectiveness	High	
	Political/social acceptability	Medium	

How does it affect transport demand?

Social values influence people's behaviour in many ways. As countries grow richer, people's values towards freedom of movement, environmental protection, and leisure time increase as well. The implications for transport demand depend on the magnitude and balance of these changes. Whilst the preference for free movement may push people to own larger and faster cars, awareness of environmental problems may work in the other direction.

Figure B.10 The Environmental Kuznets Curve



Source: Yandle B *et al.* (2002).

What can be done about it?

European countries have historically moved away from a government-interventionist, community-oriented society towards a free market, individual-oriented society. This trend is more likely to continue than not, and limits the extent to which governments can influence trips and modal choice (Lyons, G *et al.*, 2002).

A better understanding of social values may help policy-makers formulate realistic options that work in practice. Public transport can be encouraged in major metropolitan areas and main corridors, but not where travel demands and patterns are individualised (Lyons, G *et al.*, 2002).

The latter is better tackled through promoting energy efficient vehicles and higher vehicle occupancy.

Education for both children and adults regarding the causes and effects of climate change may change behaviour to a certain extent, as witnessed in the increasing popularity of fair-trade and 'green' products, and carbon-offsetting schemes.

European Environment Agency

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