

**DTLR**

**DEPARTMENT FOR TRANSPORT,  
LOCAL GOVERNMENT AND THE  
REGIONS**

**The Impact of Information and  
Communications Technologies  
on Travel and Freight  
Distribution Patterns:  
Review and Assessment of Literature**

**Final Report**

**HOP ASSOCIATES**

In association with  
**TRANSPORT RESEARCH GROUP  
UNIVERSITY OF SOUTHAMPTON**

**January 2002**

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# 1 INTRODUCTION

## 1.1 Purpose of the report

This report is the draft Final Report in the project *The Impact of Information and Communications Technologies on Travel and Freight Distribution Patterns: Review and Assessment of Literature*. (For the purpose of this report we shall abbreviate both the title and the central concept of the study to *ICT Impacts on Transport*.) The report is draft in the sense that we anticipate some feedback from DTLR and from the seminar due to be held later in January. The conclusions, however, are the researchers' considered opinions based on the material assessed, and we do not anticipate at this stage substantial changes to the core ideas expressed in them.

This report will:

- Outline the activities undertaken in the project
- Summarise the key findings in the evaluated literature
- Analyse the findings in a number of key thematic areas
- Summarise our conclusions
- Propose a number of recommendations for future action.

The report focuses on the practical issues involved in gaining reliable knowledge about the impacts of ICT on transport. We have tried to separate what is actually known from what is possibly known and from speculation that is not based on any credible data. This emphasis is based in part on the desire of the DTLR that the project should not sit on the fence. It is also based on many years experience in a field where so many studies have said, more or less, "the effects may be this, or they may be the opposite".

Summaries and critiques of individual research projects and papers can be found in the research database. (However, summaries of the studies reviewed are included in the appendices.) This report does not attempt to duplicate the function of the database, but to synthesise the findings and provide an overall evaluation of the literature and the state of the art.

The project has been undertaken at an important time in relation to the future direction of UK transport policy. The government has committed itself to reducing car dependence. Public transport seems to be at something of a crossroads. The first tentative steps have already been taken to promote the use of ICT as a means of reducing travel. ICT-based initiatives in both the private and public sectors are being developed in ever increasing numbers.

What is needed at this point is a greater understanding of the role that the use of ICT-based applications such as telework, ecommerce and electronic service delivery might play in reducing the need to travel and to physically transport goods. Whether the effects of ICT are to reduce travel, increase travel, displace it or are largely neutral, transport policy-makers have a need to know. This report and the accompanying database provide the initial steps in collating the available knowledge, and providing signposts for future research to fill the gaps in the data.

## **1.2 Objectives of the project**

The objectives of the study as outlined in the HOP/TRG proposal are to:

- identify research from across the world that examines the impacts of the new ICT on transport
- summarise the approach, conclusions and recommendations of identified research
- provide a brief critical review of the research methodologies and results
- assess the value and transferability of research methodologies for the UK context
- identify supporting research and monitoring activities which may contribute to an understanding of developments in this field
- provide the beginnings of a knowledge base for future possible DTLR (and other UK government) research and monitoring activities in this field.

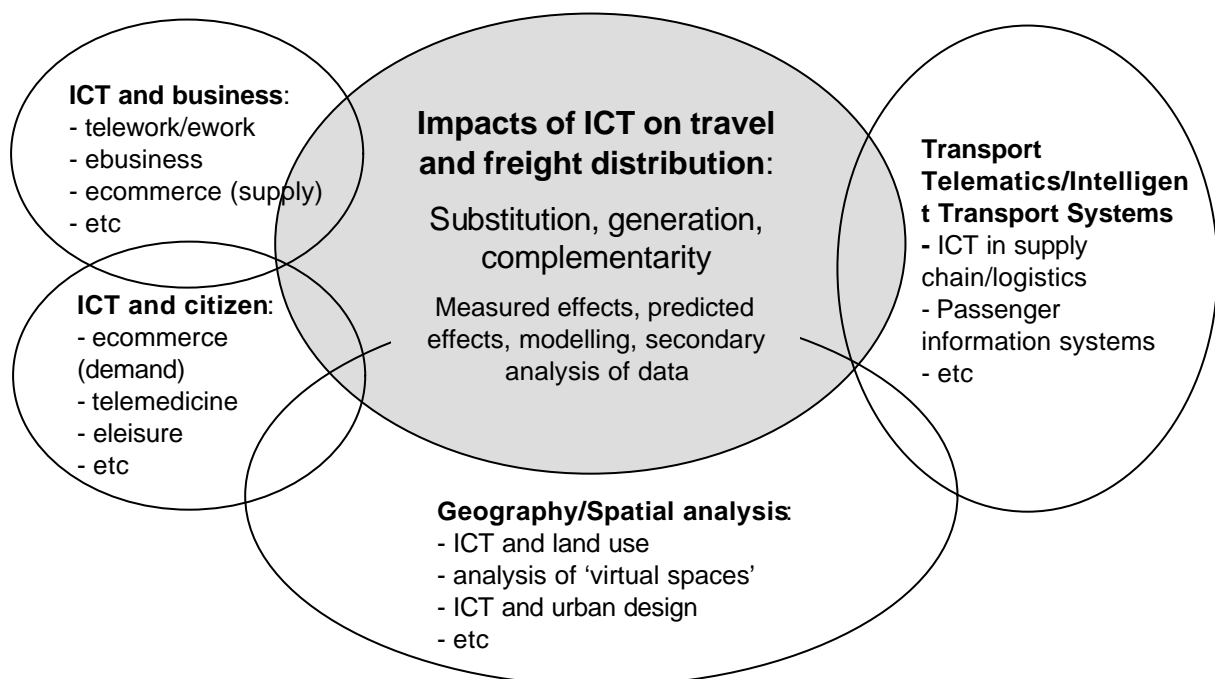
## 2 PROJECT ACTIVITIES

### 2.1 Defining the scope of the project

At the outset of the project, HOP and TRG sought to clarify the scope of the project. We were able to identify a wide spectrum of research activity in the field of ICT and transport. While the primary sphere of study was clearly defined in the tender brief and the proposal, it is an area with overlapping boundaries.

The figure below sketches the overlapping fields of study:

**Fig. 1 Focus of the Literature Review and related areas:**



There are many studies that consider the role of **ICT in business**. For the most part they research or promote ICT for organisational development, exploring the management, facilities, personnel and IT issues. There are many valuable "how to" guides which outline the field and will help researchers to understand the significance of ICT for business and the driving forces behind its development. Where they mention the effects on transport, it is almost always in relation to telework. These studies generally do not move beyond broad statements about the potential for travel reduction and associated business, personal and environmental benefits. Sometimes they include figures gleaned from transport-related studies, and some contain short case studies illustrating travel reductions. For the most part we have not included these in the database for full review as they do not add to the base of transport-related knowledge. Some, however, are included as summary entries, as they may provide useful background material. There are many evaluations of implemented schemes in this field, but which focus on issues other than transport.

An increasing number cover ebusiness or ecommerce (variously defined). These may be “how to” guides, or explorations of the issues. They rarely mention transport.

The field we have styled “**ICT and the Citizen**” covers issues such as the deployment of public services using ICT, access to ICT (including the “digital divide”), best practice in developing community-based ICT facilities, e-learning programmes, and so forth. Transport issues may be included, but usually as an additional reason to support development of ICT for other purposes.

The field we have styled “**Geography/Spatial analysis**” covers urban and other geographical studies that analyse the impacts of ICT on land use, urban design, architecture and planning. There is a subset of the literature that attempts to map virtual spaces and interactions. To some extent this field overlaps with all the others, in that findings from the various fields impact on the future shape of our urban and rural areas. There is quite a history of futurist studies looking at possible spatial and environmental impacts of ICT on society.

The field of “**Transport Telematics**” and “**Intelligent Transport Systems**” describes the issues that perhaps most readily spring to mind if one mentions “ICT and transport” to transport professionals. This is where funding for research and development tends to be channeled in relation to ICT. Areas covered include dynamic passenger information systems, smartcards and through ticketing, traffic control systems, intelligent vehicles, and ICT in supply chain management and logistics. These are all clearly related to transport, but in the sense of using ICT to for new or improved processes and systems, and providing information in more dynamic ways. Some aspects may have impacts on traffic volumes and mode choice, though this is often anticipated rather than quantified.

In selecting the studies to include in the Literature Review we have been guided by whether the study has a primary focus on the transport substitution/generation/redistribution effects. It may well be, for example, that using ICT to improve the efficiency of supply chains may create the possibility for more or less trips to take place. However, studies that focus on the development of such systems are not included in the literature review. Where, however, the wider traffic impacts of their use in ecommerce are measured, or the discussion of this is taken beyond generalities, they are included in the review.

A similar principle applies with research into innovative uses of ICT for business and other social purposes. For example, there is a growing literature relating to teleworking, the primary focus of which is on its effects in business – on efficiency, on HR issues, on property and facilities, etc. Usually some evaluation of, or reference to, the (potential) transport effects is included in such studies. We have had to make a judgment as to whether the transport-related elements are based on anything substantial, or on information not covered in the other studies we are reviewing.

The core of the study is the impact of the use of ICT on travel behaviour and freight distribution, in terms of new ICT-based applications changing the way people travel and changing the way goods and services are delivered. The key questions in this field are:

- How is travel replaced, generated or modified by applications such as teleworking, ecommerce and other electronically mediated activities?
- How is the movement of goods replaced, generated or modified by applications such as ecommerce?

Literature that directly addresses these questions is included. Studies in the related fields are included only where they shed some light on the core issues of this project.

## **2.2 Research database**

One of the first tasks was the development of a database to use as a research tool. This database can be found at the following web address:

<http://www.hop.co.uk/ICT2002>

A user ID and password are needed to access this information.

An initial prototype was developed and then revised in the light of comments from the DTLR. This revision also formed part of an initial testing of the methodology for assessment. As studies are evaluated, they are entered into the database.

Using this database has a number of advantages:

- Its structured format helps to ensure that research is reviewed using consistent criteria
- It can be searched in a variety of ways: for example, the entire knowledge base of evaluated studies can be searched entering a keyword or author, or it can be searched according to subject matter – e.g. all studies dealing with commute travel.
- It will remain with the client as a tool which can be added to as future studies are completed
- It assists comparative evaluation through the “scoring” mechanism for certain criteria, helping also to identify areas of strength and weakness in this research area, and opportunities for new research.

The database is available also for download in MS Access format.

The database was modified following further suggestions from the DTLR so that a list could be made of all literature found in this field. Summary entries are made for studies which the researchers have not put forward for detailed evaluation.

## **2.3 Refining the methodology**

Both the database and the methodology were tested at the beginning of the project, with both TRG and HOP writing up a number of evaluations. These served as the basis for feedback from the client, as well as for HOP and TRG to test out the proposed methodology.

Minor changes were then agreed to the process of summarising and reviewing the identified research. DTLR indicated that the reviews and the database were likely to enter the public domain, and stressed the need for accessible language and incisive commentary.

The database was modified following further suggestions from the DTLR at the meeting following the Interim Report that a list could be made of all literature found in this field. Summary entries have subsequently been made for studies which the researchers have not selected for detailed evaluation. There are several reasons for including a study as a summary rather than providing a detailed review. It may be primarily a work with background information, with only minor and derived references to transport effects. More commonly, a summary entry will refer to a study which has been superseded by another work by the same author or in the project, or a popular article summarising a more substantial work. In some cases there are many very similar works from the same stable, and in order to avoid repetition we have had to make a judgement as to which to include for full review and which to include for summary entry.

## **2.4 Principles informing the analysis**

In assessing the value of the research findings entered in the database and summarised above, our approach has been driven by a number of principles.

1. We have put a high value on “hard evidence” – that is, where research can deliver direct empirical evidence of the impacts of ICT-based activity on transport activity. This is of course tempered by considerations of the strength of the methodologies involved.
2. We have looked closely at the assumptions involved in the studies. Many studies make major assumptions when working from data at the disaggregate level and projecting to the wider effects. Significant assumptions are also often made about the appropriateness of using certain kinds of data (e.g. census data, home internet access, etc) as the basis for secondary analysis focusing on traffic impacts. Key assumptions are often made in sample selection (e.g. looking only at certain categories of workers), and in deciding what kinds of activity to measure or model, etc.
3. Beyond the assumptions, we have examined the coherence of the methodologies used, particularly with an eye to their transferability to the UK context.
4. We have also considered the range of understanding involved. This is important in an essentially inter-disciplinary field. To some extent it is unfair to expect researchers to have equally high levels of knowledge across the fields of ICT, transport, business studies, urban studies, etc. However there are many instances where potentially valuable research is undermined by a simplistic, or perhaps artificially simplified, approach to their non-specialist area.
5. Many of the studies reviewed contain effectively no data, but propose theoretical models, new paradigms, etc. Many of these are valuable additions to the field of study. In these we are particularly concerned with issues of conceptual rigour, and helpfulness of new definitions, recommendations for new areas of methods of research (and so forth), and the extent to which the theoretical approach reflects current practice and known data.
6. In the fast-changing field(s) of ICT, there is a clear need for studies to be as up-to-date as possible. While inevitably studies will lose some relevance with the passage of time, it is important for their credibility that at the time of the study,

their knowledge is state-of-the-art. Regrettably, in many instances we found this not to be the case, with researchers quoting older studies and older data when more contemporary data was available. This reduces their research value. The citing of older works from the 1970s and 1980s is quite common, as if reference to previous well-known authors *ipso facto* adds authority. While some of the key concepts and speculation have their origins with original authors during these decades, technology and practices have changed so much there is little to be gained by basing research on, or against, their work.

7. A key factor in our assessment is the relevance of the study to the research and policy context of the DTLR. If in our evaluation we have found studies to be of greater or lesser value, it is important to note that (in most cases) this is not an “absolute” judgement. A study we have not found particularly valuable may have been very much state-of-the-art in its time, or have great value in a different context.

## **2.5 Overview of studies located**

In the trawl for completed research the focus for TRG has been studies on freight impact, and for HOP studies on impacts from teleworking, individual and business use of ICT, and studies of a more wide-ranging nature. Both HOP and TRG have helped in identifying resources for evaluation by the other partner.

There have been a considerable number of research activities that have been carried out over the past 15 years or so in this field, although the numbers of research centres involved in this type of research appears to be relatively limited. Some researchers have been particularly prolific, with a certain amount of replication (or at least strong overlapping) of the literature.

Since 1998 there has been something of an explosion in the amount of literature, as subjects that were largely considered “fringe” have, at least to some extent, moved into the mainstream. This is particularly true of studies on the various forms of ebusiness and their effects.

A thorough search has been conducted by TRG for studies that provide meaningful insight into the actual and potential impacts of ICT on freight distribution patterns. These impacts are expected to derive largely from the applications of business-to-business and business-to-consumer ecommerce and related processes. Though a growing field, the relative newness of the phenomenon means that the range of serious studies is limited.

Research into teleworking has a longer history, with some of the first studies coming from the 1970s. We have not found that studies before the early 1990s are suitable for detailed evaluation in the knowledge base, due to a lack of anything other than speculative approaches to transport issues. A few studies from the earlier 1990s stand out in terms of more rigorous approaches to evaluating traffic impacts, and have the advantage of being able to report on or monitor implemented teleworking schemes.

## **2.6 Supporting information**

In addition to projects directly focusing on ICT impacts on transport, we are identifying sources of information that can provide credible supporting information for research and monitoring in this field.

These are mostly in the area of calculating the growth of IT and telecommunications products, services and markets, and of uptake by businesses and consumers.

A modified form of entry in the database is being developed to include these: they will not be evaluated by the same criteria nor in any depth beyond indicating possible value to transportation-linked research.

A list of helpful studies is included in the appendices.

It is not within the scope of this project to review in detail the methodologies of these non-transport studies and reports. Some issues in relation to their approach to the data are covered in section 4.10.

## **2.7 New research and contacts with other projects**

During the project so far we have come into contact with a number of projects currently in progress or due to start soon, but which will not report during the time-frame of this project.

A table with basic details of these for future use by DTLR is included in the appendix.

We have also been in contact with a number of organisations involved in continuing research in this area and who have supplied us with useful information and who would value information sharing. These include the Danish TRIP centre (who participated in the initial proposal), UKCEED and its associated projects, European Commission DG-INFOSO, and National Transport Secretariat of Australia.

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### 3 TYPICAL FINDINGS WITHIN THE LITERATURE

In this section we briefly summarise the conclusions of the literature we have reviewed. In the following "Analysis" section, we proceed to evaluate the validity of these conclusions.

In the literature we have observed certain patterns of results or conclusions:

- In studies of completed teleworking schemes, reductions of numbers of trips, vehicle miles and pollutant emissions are recorded.
- Full-time telework is less common than part-time. Studies tend to show an average of 1.5 teleworking days per week. The frequency of telework is emphasised as an important issue for calculating the transport impacts.
- The mileage reduction recorded in teleworking schemes varies from study to study, but generally teleworkers record longer (substituted) commute journeys than the average national commute journey. This leads to a conclusion that teleworking is undertaken more, or by inference appeals more, to people with longer commute journeys.
- The previous observation leads many commentators to suggest that the overall potential for reductions of vehicle miles travelled and pollutant emissions resulting from teleworking may be overstated (i.e. that people living closer to work will not telework to the same extent as those living further away, and this should be factored into any estimated aggregate effect).
- In speculative studies of the impact of teleworking, usually small percentage reductions in traffic levels are estimated, in each case less than the predicted rise in traffic volumes. So at best increases in teleworking would only take the edge off predicted increases in traffic.
- Largely based on studies in the US, there is a tendency to calculate that the global effects of teleworking will be to generate at least as many trips as are substituted. This view, however, is more to be found in speculative approaches than in data gathered from observed activity.
- Most commentators expect ecommerce – both business-to-business and business-to-consumer – to lead to increases in freight traffic. Few however are willing to put numbers on their predictions
- There are, however, one or two dissenting voices who feel that ICT-based increases in efficiency and productivity will mean that more goods can be delivered with the same number, or fewer, vehicles on the road
- There is no consensus about the impact of ecommerce on passenger trips – most commentators propose a number of scenarios related to different business or logistical models, some of which point to possible net increases, others to possible net decreases in overall traffic.

Some of these findings are beginning to enter the literature as a kind of orthodoxy. In the next section we examine the basis for them, and outline steps that would be need to be taken to verify findings based on limited evidence or plausible conjecture

## 4 ANALYSIS

The literature we have reviewed covers a wide area, over a number of disciplines. The following paragraphs bring into focus key themes and issues arising from our review.

### 4.1 Telework – direct evidence of transport effects

Of all the areas we have looked at, studies of telework provide by far the largest amount of empirical data about the relationship between ICT-based activity and travel behaviour. There are probably a number of reasons for this, such as its being promoted by both the US government as a response to the Clean Air Act and by management consultants as a means to improve business efficiency. It was also a practical possibility several years ahead of Internet-based ecommerce. But perhaps most of all it has the advantage of being relatively easy to count, at least in terms of commute trips replaced, and can very easily be incorporated into surveys and travel diaries. The very concept of “telecommuting” – the more common term in the US – emphasizes an impact on the home to work commute trip. Other aspects of “telework”, as broadly defined, such as mobile/nomadic telework, online collaboration within and between organisations, and remote monitoring and diagnostics receive comparatively little coverage.

As summarised in section 3 above, the evidence from implemented schemes is overwhelmingly of significant travel reductions per teleworking occasion (which to some extent is self-evident), and per teleworker. The following table gives examples of the types of mileage reduction found per teleworker:

**Table 1: examples of mileage saving calculations**

<b>Study</b>	<b>Commute travel reduction per teleworker</b>
Mitchell & Trodd (1994) <sup>1</sup>	113 miles per week
Lyons et al (1997) <sup>2</sup>	58 miles per teleworking day
Mokhtarian (1997) <sup>3</sup>	51 miles per teleworking occasion (centre-based) 34 miles per teleworking occasion (home-based)
BT (2000) <sup>4</sup>	93 miles per week for car users 143 miles per week for rail users

<sup>1</sup> Mitchell, H & Trodd, E: *An Introductory Study of Telework Based Transport-Telecommunications Substitution*, 1994

<sup>2</sup> Lyons, G. et al: *The Potential Impacts of Teleworking on Travel: Results from a Longitudinal UK Case Study*, 1997

<sup>3</sup> Mokhtarian, P.L: *Residential Area-Based Offices Project: Final Report on the Evaluation of Impacts*, 1997

<sup>4</sup> Hopkinson, P. & James, P: *The BT Options 2000 – A pilot study of its environmental and social impact*, 2000

These results are not calculated in exactly the same way – the BT result, for example, does not include other household trips.

Mileage reductions are found whether teleworkers are home-based or centre-based. The unexpected result from the centre-based survey is attributed to the teleworkers who used the centre having even longer commute trips than their home-based colleagues. Research has found that teleworkers (in the period covered by the research) tend to work around 1.5 days per week away from the “main office” – roughly equivalent to eliminating 6 round-trip commutes per month.

Generally the figures indicate that teleworkers have, on average, longer commute trips than commuters in general. This has led to considerable speculation in the literature as to why this is so:

- Early adopters of teleworking are more likely to be people with longer journeys<sup>5</sup>
- Teleworking is in general likely to be more tempting for people with longer or more difficult journeys<sup>6</sup>
- Promotion of telework and provision of centre-based facilities has tended to focus on people with longer journeys<sup>7</sup>

There are a variety of assumptions that may be built in to the setting up of telework programmes that may influence the measured travel reduction results. One of the most important is that teleworking is appropriate for certain categories of workers only. This assumption is likely to be especially pronounced in pilot schemes. So conclusions that show that teleworking is more suitable for “knowledge workers” and/or managers and professionals tend to reflect assumptions in the selection of candidates for teleworking. This may also be a significant factor in observing the travel behaviour of teleworkers.

An assumption found more in the transport literature than in the technological or business literature is in the tendency to treat telework as a single phenomenon regardless of the technologies and business processes involved. The quality of the telework experience would appear to have an impact on the frequency of teleworking. This may even be designed into the teleworking scheme. For example, the AA virtual call centres are set up with seamless access to all the office systems, to allow 100% home-based teleworking. At the European Commission, 3 categories of telework (“hard”, “medium” and “soft”) were introduced on the basis of selected staff’s need to telework. Different levels of technology, and access to office systems were provided accordingly. In each case frequency of telework occasion is directly linked to technology provision. In turn this impacts on the travel substitution potential. This is an area that needs to be studied more closely.

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<sup>5</sup> e.g. Shafizadeh, K.R. et al: *The Costs and Benefits of Telecommuting: An evaluation of the macro-scale literature*, 1997; Huws, U: *Teleworking – An Overview of the Research*, 1996

<sup>6</sup> e.g. Mitchell, H & Trodd, E: *An Introductory Study of Telework Based Transport-Telecommunications Substitution*, 1994. The authors drew the conclusion that government policy should target long distance commuters in particular, not only as these were more likely to find it attractive, but it would achieve greater travel savings. In the study by Lake, A.S. & Van Vuren, T.: *Assessing the Impact of Advanced Telecommunications on Work-related Travel*, 1997, this was a clear finding from the attitude survey

<sup>7</sup> Bagley, M.N. et al: *Telecommuting Centers and Related Concepts: A Review of Practice*, 1995

Methodological issues are also raised by many of the case studies. From the case studies it is often not possible to penetrate far into the methodologies employed – this is particularly so for commercial case studies. Case studies provided by publicly funded research tend to be more transparent. Typical weaknesses in methodologies are small or unrepresentative/self-selecting sample, travel diary data covering only a very brief period of time, inconsistencies in groups or time periods compared, and limited coverage of travel-related activities.

These weaknesses are noted by most of the commentators, and many suggestions are put forward to improve future research (see below, 4.11).

It is useful to distinguish between the direct and the indirect, or secondary, effects of teleworking. We might define the “direct effects” of teleworking as being journeys eliminated by a person teleworking, and additional journeys made by that person or another person as a result of his/her teleworking. That is not the end of the story, however. Researchers are also interested in wider effects related to the use of ICT. These wider secondary effects, such as relocation, urban sprawl, other road user occupying vacated roadspace, etc, are considered in more detail in section 4.3.

Many studies comment that the traffic reduction effect of teleworking will be counterbalanced, at least to some extent, by teleworkers, or other household members, undertaking other journeys which previously would not have been made, or would have been made as part of a commute trip. Few, however, have attempted to measure this. Where this has been done, the evidence is that there remains a net substitution effect<sup>8</sup>. In a number of studies, researchers express surprise that the opposite effect is recorded: other business and household journeys also decreased, adding to the substitution effect<sup>9</sup>.

A rare example of new trips that are generated for colleagues being measured is in the AA virtual call centre study<sup>10</sup>. In this work environment substantial new mileage is generated by managers who travel regularly to visit their remotely-based staff. The new mileage, though large for the individual manager, does not eliminate either the mileage reductions or cost savings. The number of trips made by managers reflects in part the organizational culture and in particular the working practices of call centres, where close and personal supervision is typical.

Some measurement has been done of the transport effects of introducing teleworking for field staff<sup>11</sup>. Measurements rather than estimates, however, are comparatively rare and more research needs to be undertaken with larger samples. For the organisations concerned, the main focus has been efficiency and better service delivery. This has meant that effects beyond the commute journey and business travel have for the most

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<sup>8</sup> Mokhtarian, in various works, has calculated that these more direct knock-on effects may reduce the travel savings by around 50%

<sup>9</sup> This effect is noted in the studies by Hamer, R. et al: *Teleworking in the Netherlands: an Evaluation of Changes in Travel Behaviour*, 1991; Kitamura, R. et al: *Telecommuting as a Transport Planning Measure: Initial Results from the State of California Pilot Project*, 1990, and in Lyons, G. et al: *The Potential Impacts of Teleworking on Travel: Results from a Longitudinal UK Case Study*, 1997

<sup>10</sup> Hopkinson, P. et al: *The Impacts of Teleworking - A Study of AA Employees*, 2001

<sup>11</sup> e.g. at Hertfordshire County Council Trading Standards. Jupp, S: *Miles Better*, 1998

part not been examined. There is often an assumption that mobile teleworkers will increase the number of journeys they make, resulting in a net increase in travel. This has not yet been demonstrated.

Despite the observations on the direct net effects of telework cited above, many researchers share the view of Patricia Mokhtarian<sup>12</sup> that:

“the preponderance of evidence suggests that when the scope of the inquiry is broad enough, the net impact of ICT is to generate more communication, including new travel”.

We examine this issue – how far do we cast the net looking for the net effect? - in section 4.3 below. However, as far as *directly observed effects from historically recorded data* are concerned, the overwhelming evidence is that teleworking does lead to reductions in travel, both in terms of PMT and VMT. The wider effects anticipated or attributed, are not supported by the direct studies of teleworking – although sometimes this may be because they do not include them within the scope of their inquiry.

Many of the studies in this category, however, do attempt some extrapolation of the wider – e.g. metropolitan or national – potential transport effects of teleworking if their findings were generalised to the population as a whole<sup>13</sup>. This is usually approached with some caution by the researchers, but often makes for eye-catching reading and provides the messages that hit the headlines.

These kinds of calculations take two forms, in each case starting from the observed travel reduction figures:

- Estimating the wider uptake on the basis of the kinds of teleworking observed (e.g. by basing estimates on the number of possible knowledge workers<sup>14</sup>)
- Estimating the wider uptake on the basis of figures from other teleworking surveys (such as figures from the Labour Force Survey, or TELDET or ECATT projects)

There are serious limitations to this kind of exercise, not least the problem of not knowing how many teleworkers and potential teleworkers there are, how often they telework and what kind of journeys they have. Figures from surveys (such as those cited) that count the numbers of teleworkers have significant methodological problems of their own.

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<sup>12</sup> Mokhtarian, P.L: *Telecommunications and Travel*, 2000

<sup>13</sup> Examples of this are Mitchell, H & Trodd, E: *An Introductory Study of Telework Based Transport-Telecommunications Substitution*, 1994; Moss, L.M. and Carey, J: *The New York Telecommuting Project*, 1991

<sup>14</sup> Gillespie et al: *Review of Telework in Britain: Implications for Public Policy*, 1995

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## 4.2 Telework – indirect evidence of transport effects

There are numerous secondary studies examining the effects of telework on travel behaviour. These take the form of:

- Literature surveys, taking an overview based on other studies (including case study material)<sup>15</sup>
- Speculative studies, based on primary research of attitudes to telework (rather than implemented schemes) and other travel data<sup>16</sup>
- Speculative studies, based on examination of data related to teleworking but which was not designed for the purpose of examining transport issues.

Two key issues in such studies, before addressing transport issues, are:

- Who counts as a (potential) teleworker, and
- How many of them are there?

Many studies begin with definitions of teleworking (or telecommuting). Studies frequently separate teleworkers into classes according to location – home-based, centre-based, mobile/nomadic, satellite office, etc – and describe the necessary workstyles and technologies for classification as a worker. In practice the vast majority of studies focus on home-based teleworkers. Factors that distinguish teleworkers from traditional home-based workers are usually outlined.

A key factor in many studies is the amount of time that one has to spend teleworking before one is counted as a teleworker. Some of the older studies only include as teleworkers people who spend the majority of their time working from home. More recently a broad consensus seems to be emerging that distinguishes 3 temporal classifications of teleworkers: full-time teleworkers; part-time teleworkers (part time meaning spends at least one day per week teleworking); and supplementary teleworkers (i.e. people who regularly practice teleworking *in addition* to regular attendance at a traditional workplace). An additional category loosely applied is “ad hoc” teleworking, which may mean people who occasionally telework as needed, or can mean people who often telework but do not officially have permission to do so.

In the UK, changes to questions in the Labour Force Survey have brought greater stability to the definitions and consistency to who is counted in. It now distinguishes between traditional homeworkers and people using ICT in homeworking, and counts all people who have teleworked for one day per week or more. These statistics still have limitations when considering the frequency of teleworking occasions, as their purpose is

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<sup>15</sup> e.g. Huws, U: *Telework: An Overview of the Research*, 1996; Gillespie, A. et al: *Review of Telework in Britain: Implications for Public Policy*, 1995

<sup>16</sup> e.g. Lake, A.S & van Vuren, T: *Assessing the Impact of Advanced Telecommunications on Work-related Travel*, 1997; Amarach Consulting for Dublin Transportation Office: *Telecommuting: The Shortest Route to Work*, 1998

to count heads rather than teleworking occasions. They also do not pick up the “supplementary” teleworkers identified in surveys like the European ECATT survey<sup>17</sup>.

Many studies that estimate traffic impact start from the basis of the number of known teleworkers – how many there are is clearly a vital issue. Owing to the uncertainty, it is not uncommon for researchers to present a basket of estimates, and end up with “upper” and “lower” figures reflecting the differences in their basket of surveys. A number of researchers<sup>18</sup> have emphasized the crucial importance of figures for frequency of telework occasion as well. Identifying part-time teleworkers has only limited value unless we know what that means – is it 1,2,3 or 4 days per week? Timing is also important: someone who teleworks for half-days alters the timing of commute trips, but does not eliminate any on those teleworking occasions.

The process of estimating the numbers of teleworkers does seem to be improving. Projects such as the ECATT and EMERGENCE projects and the US surveys of organisations such as ITAC are finding more robust avenues for identifying teleworkers, and these supplement the official statistical sources. With the continuing refinement of survey techniques, however, there are problems in the comparability of data with earlier surveys. The ECATT and EMERGENCE projects, which are respectively Europe-wide and global, inevitably end up using differing types of data in different countries despite their efforts to achieve the highest levels of consistency.

Many surveys incorporate subjective elements – e.g. asking senior officials in companies how prevalent teleworking is in their organisation: the answers are mostly guesstimates from limited knowledge.

A recurrent practice in the absence of robust figures is the use of proxy data sets to estimate a) the number of teleworkers, and b) an upper limit for telework penetration.

A good example for this in the UK context is in the 1995 study by Gillespie et al<sup>19</sup>. The authors analyse the 1991 in order to estimate the number of teleworkers in the UK both at local and national levels. For this they assume telework to be a subset of white-collar homeworking, and mainly managerial. Despite the categorisation of several types of teleworking in the report, for quantification purposes only figures for homeworking are used in the analysis. Unfortunately 1991 census figures do not distinguish between working with ICT or any other kind of homework, and would not show up part-time homeworkers (tele- or otherwise). It is a good example of the use made by researchers of proxy data sets in the absence of more appropriate sources of empirical information.

Other proxy indicators which researchers feel relate to telework uptake and have incorporated into research include: numbers of “knowledge workers” (variously defined); trends in service sector employment (e.g. numbers of employees in data processing

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<sup>17</sup> For an overview of recent figures from several surveys, see Lake, A.S. and Crichton, R.G: *The Complete Guide to Flexible Working*, 2000, chapter 1.

<sup>18</sup> e.g. Pratt, J.H: *Asking the Right Questions about Telecommuting: Avoiding Pitfalls in Surveying Home-based Work*, 2000; Handy, S. L. and Mokhtarian, P. L: *Forecasting Telecommuting – An exploration of methodologies and research needs*, 1996

<sup>19</sup> Gillespie A., Richardson R., and Cornford J: *Review of Telework in Britain: Implications for Public Policy*

industries, percentage of employees in and self-employed in non-retail sales occupations, numbers of free-lancers, etc)<sup>20</sup>; home PC ownership; home and workplace internet access; etc. The figures themselves may be more or less robust. However, they have to be processed through a filter of questionable assumptions to be applied to deducing telework numbers and telework growth trends.

In a number of studies the telework numbers and growth trends so deduced are then used to calculate traffic and emissions impacts. The following table illustrates some of the findings:

**Table 2: Examples of projected savings from telework**

<b>Study</b>	<b>Savings predicted</b>
US Department of Transport <sup>21</sup>	2.3% - 4.5% of commuting VMT by 2002 - 17.6 - 35.1 billion miles
Shafizadeh et al <sup>22</sup>	Average 1,500-3,500 (higher and lower estimates) VMT per telecommuter per year
Dodgson et al <sup>23</sup>	10% reduction of total UK commute travel from forecast 2005 levels, 15% from 2010 forecasts
Mokhtarian, P.L <sup>24</sup>	Reduction from telecommuting "at most" 1.1% of total household travel – falling to 0.6% when possible new trips generated are factored in

These studies use a variety of different techniques to reach conclusions that are not easy to compare. They have in common, however the use of aggregate data taken from a variety of sources and apply them to national transport data.

Our view on this kind of study is that, for the most part, they do highlight important issues for transport policy. Many of them have important recommendations that would help to build a necessary understanding of new and complex phenomena for transport analysts and policy makers. However, they also serve as a reminder of the poor state of the base data for carrying out research of this nature.

They also raise many questions, to a large extent beyond the scope of this study, of the suitability of the proxy indicators used as indicators of new applications such as telework. It may indeed be the case that there are significant and useful correlations

<sup>20</sup> e.g. Huws, U et al: *ICT and Rural Areas* 1996

<sup>21</sup> US Department of Transportation: *Transportation Implications of Telecommuting*, 1993

<sup>22</sup> Shafizadeh, K.R et al: *The Costs and Benefits of Telecommuting: An Evaluation of the Macro-Scale Literature*, 1997. The figure is based on the authors' analysis of four US "big picture" studies, including studies by the Department of Transport and Department of Energy, and subjecting their methodologies to rigorous examination.

<sup>23</sup> Dodgson et al: *Motors and Modems Revisited: The role of Technology in Reducing Travel Demands and Traffic Congestion*, 2000

<sup>24</sup> Mokhtarian, P.L: *A Synthetic Approach to Estimating the Impacts of Telecommuting on Travel*, 1998

between them and the growth of telework. We explore this issue further in sections 4.10 and 4.11.

### **4.3 Telework, and the substitution/complementarity debate**

The telework “substitution/complementarity” debate is of great interest to researchers in this field owing to the potential impact on travel behaviour and the need to develop appropriate transport policies (or not).

This is an area of considerable uncertainty and considerable speculation. It is also in our view an area where there has been insufficient research, and which is often characterized by a lack of rigour.

Literature that looks at the wider effects of teleworking and other online activities and their relationship to personal travel (mainly in the US) have tended to suggest that travel substitution effects are balanced or outweighed by new trip generation. The studies, however, do not persuasively show anything beyond the observation that both traffic and telecommunications use are growing.

An influential school of thought in the US (Ben Akiva, Mokhtarian, Niles) seem to have formed the view that while the direct effects of teleworking may be to reduce travel, the wider effects of telework and other ICT use is to generate a sufficient number of new trips to eliminate the benefit (which is seen as marginal in any case) or even to increase traffic levels. For many commentators, the issue has indeed been decided in favour of complementarity.

The problem is, however, that the evidence for the traffic-generation effects of teleworking is partly anecdotal, partly speculative modelling, but mostly repeated assertions by experts. We have not found any compelling evidence (or much evidence at all) in empirical studies for the speculated generative effects. This is not to say that there are no such effects, as common sense would indicate that there are likely to be. But they have not as yet been measured.

This is an area where greater rigour is important: it is essential to know what the right questions are to ask. When discussing substitution and complementarity studies variously, and sometimes interchangeably, speak of telework, telecommunications, IT, ICT (etc). It is important to adopt precise and meaningful terms and parameters for discussion. For example, a paper focusing on telework may throw in to the balance against observed travel reduction effects of teleworking the possibility that greater use of the Internet may stimulate a desire to travel more – e.g. that online booking of flights and hotels may lead to an increase in travel. This may or may not be true, but researchers and policy-makers need to ask if such an approach is coherent.

IT, or ICT, now underpin so many activities that it is not helpful to bundle them all together. The question becomes far too general to be helpful. Both telework and online transactions may be related to ICT-literacy and availability of technology. But in terms of their relationship to household activity and to travel it is more helpful to consider the one in the context of work-related travel and the other in the context of leisure/discretionary travel. Only if it can be demonstrated that teleworkers are more likely to *alter* their discretionary travel *because* they are teleworkers should the two phenomena be brought together and weighed in the one balance.

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From a policy point of view, it is helpful to know, for example, if telework reduces travel but online services tend to increase travel. Then policy can encourage the one, and seek to limit the ill effects of the other. From an academic standpoint it might be interesting to assess the overall impacts of ICT, but from a practical point of view it is much more helpful to know the pros and cons of distinct ICT applications.

A factor involved more directly in assessment of the net effect of telework is that of latent demand. There are several aspects to this, revolving around the following questions:

- To what extent will latent demand be realised by other road users taking advantage of "liberated" road space?
- To what extent will new trips be made by the home/telecentre worker during the course of the day that would otherwise not have been, or by other family members using the car?
- How proportionately will transport substitution affect different traffic modes (e.g. will regular public transport users become occasional car users)?
- Will ICTs in due course affect location decisions so that people will tend to live further from their places of work, and therefore make fewer, but longer trips, and possibly contribute to urban sprawl?

In various forms these questions are posed in many studies. Again, they are mostly posed as questions, or are suggested as potential counterweights chipping away at the possible benefits of transport substitution through ICT use. Few studies, however, attempt to measure them. Those that do<sup>25</sup>, however, are unable to work with models for predicting latent demand that are based on "Information Age" calculations. Rather, the methods of estimating latent demand are derived from historical transport data and models that take no account of the impact of ICT. This question of modelling for new forms of behaviour for ICT-related trip substitution and generation is followed up in section 4.9.

The question of other trips being made because a car is available at home is an important one. The few studies that tackle this head on show that few if any new trips are undertaken by the teleworker or other family members. Most studies emphasise that this is an important area for future research. The limited findings suggest that it is important not to adopt too mechanical an approach to the issue. For example, it is often assumed that if delivering children to school, or visiting shops, form part of a journey to work, a car trip will still be necessary for the school run or shopping trip if the worker telecommutes. Eliminating the commute, however, creates the time and opportunity for use of other modes for these activities – such as walking. There are complex issues here involving reassignment of activities to other times, to other locations, to other people, and to other modes.

Our view is that this is an important issue for teleworking *as it is for all modal shift activities*. The DTLR is currently promoting Travel Plans to reduce (single occupancy)

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<sup>25</sup> e.g. US Department of Energy: *Energy, Emissions and Social Consequences of Telecommuting* 1994; Lake, A.S. and van Vuren, T: *Assessing the Impact of Advanced Telecommunications on Work-related Travel*, 1997; Niles, J: *Beyond Telecommuting: A New Paradigm for the Effect of Telecommunications on Travel*. 1995

car travel. Teleworking is promoted as one option alongside walking, cycling and public transport. Each of these involves leaving a car at home, potentially for use by other household members. Amongst these options public transport is unique in that it requires by its nature additional trips by another mode to be generated in order to use it (unless the worker lives and/or works at a public transport depot!). There is substantial evidence that the promotion of park-and-ride facilities generates additional car travel<sup>26</sup>: nonetheless it is considered beneficial to reduce car trips from congested urban areas even if it risks increasing them in less congested rural areas. It would be valuable to have research along similar lines examining any geographical displacement of trips that may result from teleworking, rather than the somewhat simplistic “plus or minus” conjecture that currently characterises the debate in relation to teleworking.

The comparability with other modes is also relevant in terms of the speculation about the relationship between travel reduction through teleworking and trip-chaining and multi-purpose trips. On a common sense basis, many commentators speculate that if the work journey is eliminated, other journeys will be necessary for activities that were previously dovetailed into the work journey. Though the speculation is coherent, empirical evidence is lacking one way or the other. Several of the studies focusing on activity-based modelling techniques outline approaches that might deal with such issues. But to our knowledge the kind of household activity surveys required for this are not yet being carried out. Many of the suggestions in the surveyed literature would be very valuable if pursued in the UK context<sup>27</sup>.

We note an area of imbalance in comparing telework research to that for other modes, in that there are also similar trip-chaining issues for mode-shift as for teleworking<sup>28</sup>. Public transport users, cyclists, walkers and car sharers may now need extra journeys to fulfill activities that previously formed part of one tour. Latent demand, too may erode the benefits of mode-shift as much the same way as any benefits of transport substitution through ICT use. Yet public policy champions mode-shift while remaining wary of similar side-effects from teleworking. The point here is that a rounded approach is needed to research in this area, which can set teleworking in the wider context of changing travel behaviour and managing demand, rather than treating it as having completely unique transport impacts. It may also be that more robust approaches to measuring the complementary or generative impacts of other modes could be developed in tandem.

We have a situation in the literature, then, where the travel-generating effects of telework and other ICT applications is based mostly on plausible conjecture. It is, however, worthwhile looking a little closer at such conjecture to see if it can help pinpoint useful areas of future research. The factors outlined in the four bullet points above about latent demand are all measurable. The first three have the capacity to be incorporated into travel diaries, household activity surveys and case study evaluations. It seems that the main reasons for not doing so hitherto are costs and an unwillingness to make heavy

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<sup>26</sup> e.g. Parkhurst, G: *Environmental Cost-Benefits of Bus-based Park & Ride Systems*, 1999

<sup>27</sup> see section 4.9 below, on modelling.

<sup>28</sup> Hensher, D.A. & Jeyes, A.J: *Trip-chaining as a Barrier to the Propensity to use Public Transport*, *Transportation* 20 (4), 2000

impositions on survey participants and their families<sup>29</sup>. It would be valuable if the DTLR were to develop guidelines for data collection and templates for case study evaluations so that relevant data can be collected in a consistent form, based on priorities for filling the gaps in the data.

We would suggest also that research in this area needs to have greater rigour in identifying the purpose of activities. Much of the conjecture reflects casual approaches to causality. This is typically in the form of inferring a causal relationship to contemporaneous trends or statistical correlations.

That use of both cars and ICT is increasing is evident. However, the increased use of both cars and ICT may be due to increased economic well-being or other factors, rather than that one influences the other. In order to understand the linkages better, research needs to take greater account of the purpose of activities: what are cars being used for, what are telecommunications being used for, both in teleworking and non-teleworking situations.

At this point it is useful to quote Swedish academic Folke Snickars, author of one of the better papers from an urban studies viewpoint:

“Impacts embedded in forecasting models will often beg the questions in impact analyses in that the model estimation often employs a predetermined view on the causal relationships. In a situation of rapid technological change it will neither be possible or advisable from a decision-making point of view to use historical data to address these questions. The current situation in policy analysis seems to be that a large amount of emphasis is placed on analysing existing transport systems, where we have relatively little uncertainty about the technological options. At the same time, the lack of stable information about the emerging information technologies is often put forward as a reason for not studying their societal impacts.”<sup>30</sup>

In order to model ICT impacts on transport, it is necessary to develop insights into causal relationships – e.g. are extra household trips happening because someone is teleworking, or are they the product of unrelated factors that are found in comparable non-teleworking households?

#### **4.4 Urban sprawl and related issues of location**

In terms of urban sprawl and the potential for more dispersed geographical location - which are often lumped together but which are not the same thing - it is again the case that no studies have been undertaken which might demonstrate any causal relationship with teleworking (or other ICT-based activities). Empirical data is almost completely lacking apart from a few measured telecommuting implementations where people moved house. In these cases the small numbers who did were asked if the availability of telecommuting as an option made a difference to their relocation decision. The

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<sup>29</sup> see Pratt, J.H: *Asking the Right Questions about Telecommuting: Avoiding Pitfalls in Surveying Home-based Work*, 2000

<sup>30</sup> Snickars, F: *The Sustainable Network Society – A Scenario Study of Transport and Communications*, 1999

results are inconclusive, but have suggested to some commentators that this could become a significant issue if telecommuting becomes widespread.

Many studies emphasise the need for longitudinal studies – recommendations we support as the only route to understanding the longer-term effects of the adoption of teleworking. In the literature we have reviewed there are many assumptions about the potential for teleworking to lead to less frequent but longer journeys. But until such longitudinal studies are undertaken we will be left with only assumptions and speculation.

In the field of geographical/urban studies, there have been numerous papers since the mid-1970s speculating on the spatial impact of IT and telecommunications. We have included a sample of those that most relate to transport issues in the database. However, in general we have found that they tend to be high on theoretical constructs but lacking in empirical data. They also tend to be unconvincing in terms of technological understanding, and their insight into how ICT influences the locational decision-making processes of organisations and individuals seems remote from the practicalities of business and household decisions.

One study that has a more practical focus and attempts to quantify the impacts is the Cambridge Futures project. This project models seven scenarios for the future development of Cambridge (no change, densification, build in green belt, new settlement, etc). Using land use and transport models it examines the effects on the local economy, traffic levels, employment, house prices and other factors. The scenario of interest to this project is that of developing small highly “wired” settlements along a “virtual highway” (analogous to a “transport corridor”). Of the seven scenarios examined, it emerged as one of the two most environmentally sustainable options, with much lower traffic impacts than the other options. It does though also lead to further urbanisation in the rural areas and market towns.

The study, despite working with sound modelling techniques, illustrates the key problems of analysis in innovative areas. Assumptions are made about the extent to which ICT replaces travel – in the absence of authoritative figures this has to be the case (although using these techniques higher and lower estimates could also be modelled). The choice to model new “wired” settlements – rather than assuming all households in the existing urban area becoming equally wired – also tends to produce an output where ICT is associated with growth in rural areas and ICT-enabled households make fewer but longer journeys than average. A further problem is the use of transport models based on historical data and which are not calibrated to deal with ICT-based transport substitution and generation.

In the literature, particularly from North America, it is commonplace to associate urban sprawl with the expansion of telecommunications. Historically, this is more contentious. Historians tend to assert the primary importance of an increasingly prosperous middle class and the development of public transport in the 19<sup>th</sup> and early 20<sup>th</sup> centuries (prior to mass telecommunications) as key enabling factors in suburbanisation and urban sprawl. A middle position would be to accept that telecommunications are a supporting factor in post-World War II urban sprawl. On general principles, then, the expansion of telecommunications may contribute to both the expansion of urban areas and the “flight from the cities” into rural areas.

Again, however, we have not found much beyond general principles and speculation to demonstrate a causal link between ICT and urban sprawl, or people making longer trips as a result of their use of ICT.

In terms of living further from work, it is notable that much research assumes voluntary relocation. In many instances – unfortunately in most cases transport impacts are not measured – telework accompanies business property reduction and concentration on fewer sites or a single site. So a nearby workplace visited on a daily basis is replaced by a workplace further away but rarely visited. So any longer journeys are caused by the workplace moving rather than the worker. The locational and transport effects of this kind of phenomenon have been insufficiently studied. One of the effects, as with non ICT-related relocations, is that some staff quit and seek other work. The reasons for business relocation have been extensively studied in the management and land economy literature. ICT brings a new dimension to the traditional by providing a greater capacity to retain employees while moving the premises.

#### **4.5 Ecommerce and freight distribution – direct evidence**

It has been suggested that ICT will also reduce the number of vehicles on the road for non-work purposes as the need to physically travel is reduced. But it is also widely suggested that the number of transactions using e-commerce will increase and generate extra goods traffic. This part of the review has attempted to identify research that quantifies these impacts on the distribution chain.

Case studies have been examined wherever possible as well as papers describing any likely impacts from modelling work (- the latter is included in the next section). There appears to be a general consensus that little literature is available that directly measures the impacts of ICT on freight distribution<sup>31</sup>.

Many of the ICT applications reported involve the optimisation of vehicles and rolling stock. RailTrace<sup>32</sup> is a system developed by Finnish Railways and aims to improve information and materials flow regarding the location of rolling stock and consignments around Europe. The authors estimated a 5% improvement in time savings to users of the system in terms of point-to-point delivery.

In the UK, Sainsbury's now use a system to track goods deliveries (Isotrak), which allows routing to be worked out according to individual store requirements and specific collections from suppliers. The system allows Sainsbury's to prioritise movements and prepare for incoming vehicles, saving an estimated 90 minutes per vehicle per day<sup>33</sup>.

In terms of how e-shopping might influence distribution patterns, Graham Hughes, (Marketing and Sales Director of Parcelforce) speculated that Sainsbury's would generate 6.5 million home deliveries per year, assuming that 5% of its 5 million weekly customers were to switch to home shopping for half their visits in the next 3 years<sup>34</sup>.

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<sup>31</sup> Zmud J. & Arce C: *E-mobility (Electronic Travel): Measuring New and Evolving Behavior*, 2000

<sup>32</sup> Leviakangas P. & Holmberg S: *Internet-Based International Rail-Freight Monitoring – The RailTrace System*, 2000

<sup>33</sup> Brown A.: *All Seeing Eye*, 2001

<sup>34</sup> Chartered Institute of Transport: *Bringing Home the Bacon*, 1997

Hughes highlighted the fact that home deliveries are prone to creating repeat deliveries, since approximately 30% fail first time, according to his research. He concluded that there would be a need for distribution patterns to be revised to cater for the times when customers were at home or to create service centres where customers could collect their goods.

In terms of using the Internet for improving supply chain performance, a study of 250 supply-chain executives and general managers at major US corporations showed that more than half said it could greatly improve their overall efficiency, cutting unit costs by 3% per year and enhancing revenues by 5%<sup>35</sup>. Some of these improvements could come about through using ICT to make better use of existing systems, including rationalising transportation and warehouse locations.

Golob and Regan<sup>36</sup> cite interest in the growth of third party logistics (3PL) with companies using ICT to encourage more efficient use of shared transportation networks. The Internet and EDI (electronic data interchange) are being used to process orders and commercial vehicle operators are using advanced traveller information systems to improve operating performance. Current use was low, around 4% of corporate revenues, but may be set to rise. Hultkranz and Lumsden<sup>37</sup> (2000) examined seven US online grocery retailers to discern changes in marketing channels. This showed some businesses moving from Internet firms to retailers to logistics providers, while other companies moved from logistics providers to "e-tailers".

Testing the hypothesis that e-commerce would lead to large increases in light commercial vehicle numbers, Hassall<sup>38</sup> cites one case study where a company increased business growth 65% over 5 years but managed to use larger trailers and not increase its overall fleet size. A second company met a 21% increase in demand by introducing larger vehicles and reducing their overall fleet by 7%. Neither outcome was predicted by modellers and shows that the numbers of delivery vehicles may not increase as a result of greater e-activity.

The studies where researchers measure impacts tend to do so in terms of efficiency, which no doubt has an effect on traffic volumes. This effect, however, is not usually reported or estimated.

#### **4.6 E-commerce and freight distribution - models and projections**

While directly measured studies of the impact of e-commerce on distribution are thin on the ground, there is a growing literature focusing on the principles underlying the interaction between ecommerce and transport, and making projections based on various scenarios.

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<sup>35</sup> Keevil C. et al: *Opportunity for Action. Supply Chain Strategies for the Internet Era*, 2001

<sup>36</sup> Golob T. & Regan A: *Impacts of Information Technology on Personal Travel and Commercial Vehicle Operations: Research Challenges and Opportunities*, 2001

<sup>37</sup> Hultkranz O. & Lumsden K: *E-commerce and Logistical Consequences*, 2000

<sup>38</sup> Hassall K: *Emerging Trends and Hindrances for E-logistics. An Australian Perspective in 2001*

Millard-Bell<sup>39</sup>, in an article in *Local Transport Today*, cites studies suggesting increases in the number of light van movements of up to 17%. But the article concluded that it was difficult to quantify the exact impact of e-commerce on freight movements as it was still in its infancy.

Regarding home shopping and its effect on distribution, Miller and Cairns<sup>40</sup> state 'mileage savings are likely to increase, if customers are concentrated in particular locations like specific housing estates, or along bus routes.' Yet no evidence is given to substantiate this.

Other work<sup>41</sup> suggests that there could be substantial increases in delivery vehicle movements as a result of increased e-activity. United Parcel Services state that consumers are not purchasing more goods, but their mechanism of purchasing those goods has changed. As an example a distributor may only have to deliver 3 vehicle loads of goods to 15 locations in a specific time period. With greater e-shopping and the associated demands for doorstep delivery, the same company may have to deliver 3 vehicle loads to 150 different locations (the shoppers' home) in the same amount of time. Therefore there is a greater need for drivers, vehicles and sophisticated logistical control systems. These new business methods could result in increased congestion and more competition for parking spaces.

Some literature discusses the ways in which companies who are starting to develop B2C e-commerce might develop in the future<sup>42</sup>. There is a general assumption that growth in ICT will continue to open up new markets and increase revenues. Forecasts of worldwide e-commerce revenues range between \$1000 billion and \$3200 billion dollars by 2003. Kilpapa et al<sup>43</sup> predict that e-grocery sales will increase from 1% of their current value to 10% by 2003.

In contrast, some commentators point to the limited market for Internet-based applications. Graham<sup>44</sup> points out that just 2% of the world's population are currently Internet enabled. AT&T, the American Telephone and Telegraph Company, makes 80% of its \$6 billion annual profits from 20% of its customers who use mobile phones, home phones, the Internet, cable television, pay-per-view and pagers.

Browne<sup>45</sup> predicts that B2B e-commerce will lead to new group distribution strategies, becoming more demand responsive with shared information leading to a reduction in

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<sup>39</sup> Millard-Bell, A: *White Van Gridlock or a Boon for Traffic Reduction – how will e-commerce affect transport?*, 2000

<sup>40</sup> Millar.J & Cairns.S: *Home Delivery – Environmental Solution or Disaster?* 1998

<sup>41</sup> e.g. Easley B. and Easley C. *Issues and Recommendations For E-Commerce Impacts on Urban CVO (Commercial Vehicle Operations) Deliveries and Parking*, 2000

<sup>42</sup> Marker J. & Goulias K: *A Framework for the Analysis of Grocery Teleshopping*, 2000; Browne M: *E-commerce, Freight Distribution and the Truck Industry*, 2001; Hultkranz O. & Lumsden K: *E-commerce and Logistical Consequences*, 2000

<sup>43</sup> Kilpala H. et al: *Electronic Grocery Shopping and its Impact on Transportation & Logistics with Special Reference to Finland*, 2000

<sup>44</sup> Graham S: *Bridging Urban Digital Divides? Urban Polarization and Information and Communications Technologies (ICTs): Current Trends and Policy*, 2000

<sup>45</sup> Browne M: *E-commerce, Freight Distribution and the Truck Industry*, 2001

overall aggregate inventories. The potential impact of ICT on warehousing has been raised, with a reduction predicted as companies ship directly to customers. In Finland, an early Internet adopter, demand for warehousing space is declining, with a concomitant rise in the mean distance travelled by vehicles between warehouses and retailer<sup>46</sup>. The number of retail stores is also diminishing as planners opt for over-sized trade centres. This decreases the distribution of freight by trucks, but increases the mileage of private cars.

Furthermore, it has been suggested that an increase in teleshopping may render conventional supermarkets unprofitable leading to three possible outcomes:

- Abandoning retail stores and delivering from warehouses.
- Abandoning large retail stores and adopting a boutique strategy.
- Maintaining large retail stores and competing on price.

The first 2 options in particular have significant land use implications.<sup>47</sup>

Several commentators also suggest that the impacts of e-shopping may not be as large as suggested. Shopping is a social and recreational experience that cannot be replaced by tele-shopping, although some kinds of shopping are more attractive than others<sup>48</sup>. Shopping involves information gathering as well as the actual purchase and teleshopping may not be able to supplant other means of information gathering, although information requirements for grocery shopping may be limited. Delivery may require customer presence and so not be attractive, although this may not apply to grocery shopping.

Salomon<sup>49</sup> was one of the first of many to express the view that humans needed to travel out of boredom or a sense of exploration. Any reduction in travel through technology may be offset by increased latent travel demand, or substitution. Telecommunications may generate trips that would not have occurred without them. The complementarity issue applies as much to ecommerce as to telework. But as with telework, even 15 years after Salomon's observation, there is little beyond speculation about trip generation effects.

Miller and Cairns<sup>50</sup> claim that 'even with a relatively small number of customers, and vans which can only carry a few loads of shopping each, 70-80% of vehicle miles are likely to be saved if customers no longer travel to the shops by car, but have their shopping delivered by a fleet of delivery vans instead'. Yet, the 1995 Nationwide Personal Transportation Survey shows that for the average American household all forms of shopping trips account for fewer vehicle trips than commuting. Travel survey data from both Sydney and South-East Queensland in Australia show that the majority of shopping trips are short trips. According to Nariida Smith 'It is less likely that 5-minute

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<sup>46</sup> Kilpapa, H et al: *op cit*

<sup>47</sup> Marker J. & Goulias K: *A Framework for the Analysis of Grocery Teleshopping*, 2000

<sup>48</sup> Gould J. & Golob T: (1997) *Shopping Without Travel or Travel Without Shopping? An Investigation of Electronic Home Shopping*, 1997

<sup>49</sup> Salomon I: *Telecommunications and Travel relationships: a Review*, 1986

<sup>50</sup> Millar.J & Cairns.S: *Home Delivery – Environmental Solution or Disaster?*, 1998

dashes for a loaf of bread or carton of milk will be replaced by online orders, except for customers willing to pay a premium<sup>51</sup>. Intuitively, this sounds correct. However, this remains conjecture, and in a fast changing it can be dangerous to base predictions on current practices and expectations. Who 30 years ago would have predicted that millions of people would order home deliveries of products like pizzas? Round-the-clock convenience does appear to be something people are willing to pay for.

Enhancing and promoting efficiency in grocery shopping may have conflicting effects. Customers may batch shop, shop from further afield than they would personally drive to, or generate more expeditions. Increased use of ICT might reduce some of the physical aspects associated with transportation (e.g. electronic billing reducing the transfer of paper documents/bills of lading). Just-in-time manufacturing has minimised warehousing requirements but at the same time created situations where vehicles may travel half full or empty. E-commerce removes some of the needs for transport and allows for a more accurate estimation of demand. The effects, then, of ICT on freight distribution are complex, and researchers have so far been grappling with the diversity of these effects. How to weight the varying effects to gain an overall picture, and then put them in the balance with the effects on passenger travel, remains a challenge.

One study which does attempt to provide comprehensive insights into the traffic effects of ecommerce (as part of a comprehensive approach to the effects of all ICT applications) is the *Motors and Modems Revisited*<sup>52</sup> study. This revisits the projections in an earlier version of the study, and revises in an upward direction projections for the reduction of car travel due to ecommerce. Reduction (from predicted levels) of car travel will be 5% by 2005 and 10% by 2010. Delivery trips, primarily by light goods van, are predicted to increase by 0.25% and 0.5%, and freight movements by HGV are expected to decline by 17% and 18.5% by these dates.

How these figures are reached is not entirely clear. In the case of the decline in shopping trips, an extra weighting appears to be given to the rise and potential of new technologies. In this respect most other commentators are more cautious, foreseeing other obstacles to their use as well as greater trip-generation potential. The HGV figures are based on a comparatively greater emphasis on the dematerialisation of products, ICT-based efficiencies in the supply chain and logistics, and displacement of some road freight to rail and water-based transport as ICT helps these alternative modes to become more competitive again – usually in the form of combined transport options with ICT smoothing out the cross-mode logistical difficulties. The comparatively few extra trips for light goods vehicles seems to hinge on the principle that most extra goods ordered online will be carried by existing services, adding relatively few trips and implying greater efficiency.

Compared to other studies, this report is “optimistic” in terms of the transport substitution potential of the ICT applications it examines. For that reason, it tends to be regarded with some scepticism. The report is speculative, and the ideas it puts forward need to be tested in measured studies at the micro-level. Nevertheless, it is one of the

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<sup>51</sup> Smith N. (2001) *E-business Impacts on the Transport System*, Transport Impacts of E-business

<sup>52</sup> Dodgson, J et al: *Motors and Modems Revisited*, 2001. The earlier report by the same team was *Motors and Modems*, 1997

more technologically aware reports, and its overview of the different types of ICT use is valuable.

Many commentators predict that not all businesses using e-commerce will wish to develop their own logistics capabilities, leading to a growth in 3PL (third party logistic) providers. They retain doubts over who would develop such systems and how much the public would benefit from their use. Marker and Goulias have stated that 3PL companies could consolidate deliveries for B2C transactions, although the number of customers who shop from multiple stores, or the number of customers each store has, is unknown.

Where no data are available, researchers have turned to models to predict the impact of e-commerce on freight distribution. However, models are only as good as the input parameters provided, which may vary in accuracy. Differences include a wide range of social, economic and cultural factors, each of which is uncertain. The IT industry is new and highly dynamic, limiting long term forecasting. There are different types of services, each with their own markets, characteristics and needs. Changes in any segment will have consequences on the distribution industry.

In some ways, in the heady pioneering days of ecommerce, it may be rash to build scenarios around “first wave” practice. For example, the WebVan experience is cited by some commentators as one possible model for future practice. WebVan is a third party provider, and unfortunately one of the more spectacular victims of the bursting of the “dotcom bubble”. The downturn in its fortunes undermines the credibility of the model and the projected transport effects built on it. This may not invalidate the business model, however, as a similar implementation by other entrepreneurs in more propitious times may prove to be more successful.

Punakivi and Holmström looked at the environmental aspects of home delivery, using modelling to show that e-grocery could significantly reduce traffic emissions. The modelling was done using RoutPro and data from the metropolitan area of Helsinki. Results suggested that unattended reception (where deliveries are made to refrigerated, customer specific reception boxes) could reduce fleet operational costs by 60% over attended reception (where the customer accepts the delivery). Unattended fixed day deliveries could significantly reduce CO and HC emissions and reduce overall traffic mileage by between 8 and 13.6%.

Nemoto et al<sup>53</sup> discuss the relationship between business (shipper and logistic service provider) consumer and Government. They see ‘city logistics’, as distinct from ‘business logistics’, being part of a government programme to negate external effects such as traffic congestion, air and noise pollution. They assume increased demand for value added products generating freight demand supplanting traditional business. Trip lengths might be increased through global procurement, though the creation of co-operative logistics services should improve efficiency. Passenger traffic could be reduced as consumers use local pick-up points for goods collection. The authors hypothesise an increase in freight traffic in terms of vehicle-km, which might be alleviated ‘by outsourcing logistics to couriers and 3PL, and by development of e-logistics and e-fleet management’.

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<sup>53</sup> Nemoto T. et al: *Impacts of Information and Communication Technology on Urban Logistics System*, 2001

At the end of this review, we are not any wiser as to whether ecommerce will increase traffic or decrease it. However, the issues emerging do help to point the way for future more focused empirical research.

#### **4.7 Passenger transport – non-car modes**

Very few studies include measurements of the impact on public transport use. Where it is measured, totaling just a few per cent of travel of the surveyed group, the sample size is recognized as being too small to be statistically significant. Some reduction in rideshare has been noted in studies from California, believed to be due to teleworkers falling out of regular rideshare arrangements or traveling independently at a different time of day.

The European TELEURBA study carried out a study of some 2000 teleworkers in London, Madrid and the Ile de France, and modeled the effects for the cities/regions as a whole. For public transport the most detailed analysis is carried out for the Ile de France, where a reduction of between 6.5% and 7.2% is projected in public transport commuting journeys. This is based on a detailed spatial analysis of where teleworkers and potential teleworkers (based on type of work) live, where they work and their proximity to public transport routes. The methodology is not entirely clear, and sampling factors account for different treatments of the different areas studied.

Other studies have taken a broad brush approach to the data, more or less on the lines of “n% of the population have the potential to telework for t% of the time: x% normally travel by this mode, y% by this mode, and z% by this mode”. Certain restraining considerations may be factored in. Examples of this approach include the Dublin study<sup>54</sup> and the environmentally focused study by Mitomo in Japan (1999)<sup>55</sup>. Studies focusing on the Netherlands note that many of the commute trips replaced would be public transport and bicycle trips. The Japanese study also predicts reduction in public transport use by teleworkers. These results should not be surprising, given the higher use of the modes cited in the areas concerned. In Dublin a 0.5% reduction is predicted for 2006 in bus use, and 2.1% reduction in rail/light rail use. This is in part based on an extensive attitude survey that also recorded current transport mode.

Essentially, there are not any robust figures as yet for making any conclusions about the effects of ICT on non-car travel modes. There is no evidence to suggest that if there are reductions derived from teleworking and other ICT usage it will disproportionately bring about reductions in public transport use.

We note, however, differing attitudes in relation to the effects on public transport. UK and US commentators have tended to regard reduction in travel by public transport as an intrinsically negative effect. Reductions in passengers may make marginal services

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<sup>54</sup> Amarach Consulting for Dublin Transportation Board: *Telecommuting: The Shortest Route to Work*, 1998

<sup>55</sup> Mitomo et al: *Information Technology for Sustainable Societies – Public Policy Perspectives in Japan: The Case of Telework*, 1999

less viable<sup>56</sup>. The context here is one where public policy actively promotes use of public transport, in the hope that it can reduce car travel.

In the Mitomo study, by contrast, reduction in public transport use is seen as a benefit as it will make for a more pleasant experience for the other users, as it may reduce overcrowding and the strains on the system.

This highlights an area where values and entrenched habits of thinking may affect the approach to the research. The habit of thinking “buses good, cars bad” is inappropriate when considering whether a journey can be eliminated or not. There does not appear to be any reasonable grounds for hoping that telework will reduce car use without also reducing other more favoured forms of travel.

The study of the potential for teleworking in the Dublin area makes a related point, by comparing the projected car travel reduction benefits of existing public transport schemes, undertaken at great cost, to the benefits projected from teleworking at minimal cost. The Dublin study has one of the lowest projected figures for uptake of teleworking amongst the surveys reviewed.

#### **4.8 Energy and environment**

Many studies indicate a reduction in energy consumption as a result of telework. Usually this is a direct extrapolation from reduced car use, calculated either from directly observed monitoring in case studies or from application of hypothetical reduction in car use applied at a local, regional or national level using transport statistics and/or models. Many individual studies combine an element of the latter approach on the basis of “if this pattern were followed at a national level...”

In Japan teleworking has been incorporated as a measure to be promoted in order to help the country meet its emissions reductions targets under the Kyoto protocols.

In the US, studies by the Department of Transportation<sup>57</sup> and the Department of Energy<sup>58</sup> both attempted to quantify the total amounts of pollutant emissions that might be avoided by the US as a whole given predicted levels of telecommuting uptake. The latter study also attempts to factor in allowances for urban sprawl, though it is not clear what this calculation is based on.

It is interesting that some studies working on this basis attempt some quite detailed calculations. For example the Department of Energy study attempts to factor the impacts of more cold starts and shorter journeys in reducing the assumed beneficial effects of teleworking in reducing pollutant emissions. While the principle may be

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<sup>56</sup> “It can be argued that if telecommuting were to reduce the critical mass of commuters necessary to support public transport systems of car pools, it could, in the long run, lead to an increase in car dependence” – Gillespie et al: Review of Telework in Britain: Implications for Public Policy, 1995, citing the study by the US Department of Transportation. It would be interesting to see how teleworking compares to other factors, such as price, availability and reliability, as a reason for commuters abandoning public transport.

<sup>57</sup> US Department of Transportation: *Transportation Implications of Telecommuting*, 1993

<sup>58</sup> US Department of Energy: *Energy, Emissions and Social Consequences of Telecommuting* 1994

important, the margin of error in the base figures is so wide that such tinkering at the statistical edges is far from convincing.

A study at the Department of Employment in Sheffield<sup>59</sup> adopted a distinct approach, measuring total energy consumption in the office, in teleworkers' homes and in their vehicle use. This found that homeworking produces around 80% reductions in energy use in an "ideal scenario" – one where not only the commute trip is eliminated but where the office space is also decommissioned. The study is useful in three respects. First, it measures every aspect of energy consumption at home, on the road and in the office. Secondly, it serves as a reminder that the assumed economies of scale that offices theoretically achieve tend not to occur. This is mainly due to systems and equipment being always on – lighting, heating, ventilation, IT, photocopiers, drinks machines, etc – whereas in the home these are only on when needed. The extra lighting and heating etc often mentioned for home-based teleworking was found to be less than expected. Thirdly, around two thirds of an office worker's energy consumption is attributable to travel.

The problem is, as the author recognises, that the full savings are only achievable if there is property reduction. For an individual organisation, this may to some extent be possible, by introducing hotdesking, team space and concentrating operations on fewer sites. But in reality, unless the surplus building is knocked down, or converted to a less energy-intensive use, another organisation will move in with its own energy use demands.

The Sheffield study appears to be one of a kind. Though the "80%" reduction figure may raise some eyebrows, and would require extensive demolition of offices under some kind of teleworking command economy to achieve, the study has clearly taken a rigorous and all-inclusive approach to the measurement of energy consumption. Further studies of this nature, in a range of contexts would be welcome.

In general, however, commentators conclude that transport substitution through telework and other aspects of ICT use will have only a very limited effect in reducing energy use and pollutant emissions. Better home insulation and more fuel efficient vehicles are amongst the comparisons made as better options for improving environmental performance.

A field of study very much in its infancy is illustrated in the works of Forseback (2000, 2001)<sup>60</sup> for the European Commission. These look at the wider environmental impacts of the "Information Society" as a whole. The studies include numerous case studies of ICT-based processes, products and services reducing resource and energy consumption, and various approaches to measuring the impacts. The resource use, energy consumption and pollutant byproducts of transport are one element of the wider picture. The case study approach makes for interesting reading, though it raises questions about the underlying methodologies of the case studies cited.

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<sup>59</sup> Wright, A: *Saving Energy and Reducing Pollution through Teleworking*, 1997

<sup>60</sup> Forseback, L: *Case Studies of the Information Society and Sustainable Development*, 2000; *The Knowledge Economy and Climate Change*, 2001

These works also explore and attempt to quantify aspects of ICT use not covered in the other literature on ecommerce and ICT. In particular the “dematerialisation” of products and services raises important issues that require further study. That is, products or services that previously were of a physical nature requiring physical movement to access or distribute are being converted to or supplanted by new ICT-based alternatives. Examples such as the replacement of answering machines by voicemail are given. Here a physical product brought into the home is replaced by an electronic service located at the exchange, and requiring no transport to implement.

One can think of other examples that are in principle measurable in terms of transport effects: the closure of branch offices and demise of traveling representatives in the financial services sector, being replaced with call centre based services. Just beginning are major developments in the music industry that most commentators think will lead to major changes in the distribution of musical products for sale. The bulk production of CDs and distribution from factory to retail outlet is expected to be largely replaced by online products and electronic distribution over the next few years. The Department may wish to consider research into such phenomena which monitors their effects as they evolve.

#### **4.9 Transport modeling**

Work is being done to build up a picture of the type of factors that need to be measured in order to model the effects of ICT (telework, teleservices, ecommerce) on residential and business location. Noteworthy in particular are the studies by Golob<sup>61</sup>, Ben Akiva<sup>62</sup> Handy and Mokhtarian<sup>63</sup> and Mokhtarian<sup>64</sup>. The principles and issues outlined in these studies may help to guide the DTLR in developing new modelling processes. In addition the paper by Joanne Pratt on the questions to ask in surveying teleworking is useful in outlining the range of issues that need to be covered, as well as the techniques for getting to the answers<sup>65</sup>.

Existing models are based on historic data – typically fairly old data – and none of it relating to ICT use replacing or generating travel. Golob and Regan have suggested that in-home travel will be so important that:

‘practitioners will come to realize that most household travel survey data collected to date will be of little use in forecasting impacts of telecommunications on travel.’<sup>66</sup>

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<sup>61</sup> Golob, T: *Travelbehavior.com: Activity Approaches to Modeling the Effects of Information Technology on Personal Travel Behavior*, 2000

<sup>62</sup> Ben Akiva et al: *Travel Demand Model System for the Information Era*, 1996

<sup>63</sup> Handy, S, & Mokhtarian, P.L: *Forecasting Telecommuting – An exploration of methodologies and research needs*, 1995

<sup>64</sup> Mokhtarian, P.L: *A Synthetic Approach to Estimating the Effects of Telecommuting on Travel*, 1997

<sup>65</sup> Pratt, J.H: *Asking the Right Questions about Telecommuting: Avoiding Pitfalls in Surveying Home-based Work*, 2000

<sup>66</sup> Golob T. and Regan A: *Impacts of Information Technology on Personal Travel and Commercial Vehicle Operations: Research Challenges and Opportunities*, 2001

There are intrinsic difficulties in acquiring the data to build the models and sub-models in innovative (and therefore unfamiliar) areas. There is considerable discussion, for example, about the value of stated preference surveys for acquiring the necessary data. However, people in general do not have well-formed views on innovative services and applications until they have some direct experience of them – either direct participation or close connection to someone who uses them. On the other hand (as many commentators point out), early adopters may have an enthusiastic pioneering spirit which can equally distort findings if only their attitudes are incorporated.

However, the two main obstacles at present are:

1. The lack of reliable data on ICT use, and
2. The complexity of the field.

With regard to the first of these, we put forward suggestions in the section below on Research Needs (section 4.11).

With regard to complexity, we again emphasise the need for specific and measurable approaches to research. An example of a study that falters on the complexity question is the study by Mokhtarian and Meenakshisundaram (1998)<sup>67</sup>. Though this study was based on empirical data, it raises the same issues as outlined above (section 4.3) in relation to more speculative approaches – that is, not taking into account the variety of reasons for increases in ICT use and transport use. Observing the growth or otherwise of telecommunications and traffic is relatively unhelpful unless we know the purpose of the trip or communication event. To make headway on the relationship between these activities we need to segment and model discrete activities and the applications that support them. We suggest an outline for identifying manageable areas for research in section 4.11.

To some extent this has already happened with two aspects of teleworking – the home-based and the centre-based varieties. Progress has been made in these areas because researchers have focused on manageable and measurable phenomena. Further progress on modeling the transport effects of these access-to-work applications is nonetheless hampered by lack of progress in other areas: on the one hand by the lack of similar data in regard to other applications (e.g. mobile teleworking, online shopping applications, etc), and on the other by rigorous studies of the non-transport factors which are conducive to or militate against these kinds of teleworking at the aggregate level (e.g. socio-demographic, occupational, household, etc). Only a programme of targeted studies can dispel the assumptions and conjecture that surround these.

#### **4.10 Direct and indirect data**

We have mentioned the extensive use that has been made of proxy data sources as indirect means of measuring the uptake or potential uptake of ICT applications. While we believe it is correct to be highly sceptical of their value in measuring or forecasting travel behaviour, that is not to say that in themselves they lack merit. It is only the Procrustean analyses into which they are pressed and stretched that are at issue.

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<sup>67</sup> Mokhtarian, P.L. & Meenakshisundaram, R: *Beyond Tele-substitution: A Broader Empirical Look at Communication Impacts*, 1998

It is quite possible that a variety of non-transport and other tangentially related studies may prove to be of use as indicators. This can be in general or in more specific ways. There are a number of studies which shed light on the growth of the "Information Society", using a variety of indicators<sup>68</sup>. They tend to cover trends such as PC ownership at home and in the workplace, Internet access, average spend, etc. These may be related to demographic information, size or sector of company, and so forth. Business-related studies may include more detail on technology use, whether a company has a website, whether they have conducted any business online, using EDI, intranets, extranets or the Internet, etc.

Some of the commercial studies (e.g. from Datamonitor, IDC, etc) may go into some detail on the value of ebusiness/ecommerce transactions. These clearly have potential value in looking at growth trends in the market. But one has to approach these and public sector-commissioned surveys (e.g. Spectrum for the DTI) with caution for a number of reasons:

- Despite attempts at precision, the figures tend to be very "ball-park": in the case of ecommerce this can mean variations of many \$ billions in the value of the market
- This is a fast moving field. Academic studies that rely on them typically use data which is already at least 18 months old and tends to lack credibility
- Many of the projections have turned out to be suspect in the light of the "dotcom downturn". Given market fluctuations, we are at a very early stage for predicting reliable long-term trends
- Economists are strongly divided in any case on how to measure the value of the "new economy": some think it is significantly undervalued, others believe it is over-hyped
- Ecommerce figures do not tend to distinguish between products and services that are entirely electronic ("immaterial") and can be delivered online, and on the other hand products and services that are transacted online but require physical delivery, implementation or installation. From a transport point of view, this distinction is crucial
- Too much can be made of certain data. A commonly used indicator is "x% of companies have websites". (This will tend to be in the region of 100% for large companies, and 40% for SMEs.) Though useful in that they provide something to say in local economic reviews, it would be risky to assume anything in relation to ecommerce activity from this. What counts as ecommerce can also be misleading: a company may be tallied in a survey as "using online transactions" but it may be as little as sending out a report requested by email. Unless the nature and volume of the transactional activity is recorded, it has limited value.
- Most reports are based on sampling: this may be quite sound at the appropriate level, but we have seen reports that break down activities at regional level in unconvincing ways using very small samples.

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<sup>68</sup> Studies are listed in the Appendix

Broad brush approaches that see growth in certain sectors (as general as “services” or certain service industries), or growth in telecommunications as indicators of growth of ecommerce or telework, can be of value as background. But at this stage it is not appropriate to see them as indicators of *specific levels* of growth or change in any ICT-based activity. For example, some studies see a 3% growth in white-collar work as indicating a likely similar growth in the base level of teleworking (which may be modified by other factors affecting uptake).

The process needs to work the other way around, if it is not to remain too general. Research needs first clearly to establish that there is a correlation between the rate of growth of telework and particular socio-economic trends. Research has already thrown up some surprises. For example, many studies had assumed that telework would be particularly attractive to women. This was assumed from the dominance of women in traditional forms of homeworking. Recent studies have shown that around 75% of teleworkers are men, usually on higher than average incomes.

This finding, however, may reflect patterns of early adoption rather than long-term characteristics of the teleworking labour market. What is needed, in research terms, is a period of more detailed monitoring of the characteristics of teleworking to see if teleworkers (and their households) exhibit certain key characteristics in terms of employment and other activities which have a closer correlation to other trends in the official data. Similar principles apply to other ICT applications.

We note in the Appendix several continuing studies that attempt to quantify the number of teleworkers in the UK and elsewhere. Current methods are considerably more sophisticated than processes used in the earlier 1990s, and hopefully more accurate. These may act as indicators for the department in terms of aggregating observed transport impacts of teleworking. It is worth noting, however, that teleworking is not a single or simple phenomenon, and one also needs to have a clear picture of the typical range of transport behaviours across types of teleworking.

#### **4.11 Research needs**

In many respects, little has changed since the publication of the report by Huws in 1996<sup>69</sup> for a consortium of government departments (including the former Departments of Transport and of the Environment). This report has telework as its subject matter, but many of the issues raised also apply to other fields of ICT use. Its recommendations are worth revisiting: they identify many of the gaps in the data. Unfortunately, the recommendations have not been followed up except in one or two instances. We suspect that this may be because, amongst other reasons, further work is needed to give specific shape and direction to filling these data gaps. The departments commissioning the report have seemed unsure how to follow them up, and policy and research priorities have to a large extent been focused elsewhere, despite a new emphasis on the use of ICT for e-government and economic development.

Research projects almost inevitably include further research amongst their recommendations. The literature we have reviewed in this field is no exception. The

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<sup>69</sup> Huws, U: *Teleworking – An Overview of the Research*, 1996

need for further targeted research is very evident. A five-year embargo on new conceptual frameworks, definitions and paradigms may be appropriate, however!

The research context is that new forms of communication and transaction – or older ones applied at new intensities – are having impacts on society which are largely unresearched. These changes are very recent. The state of the research reflects this level of innovation. Research into the transport effects of ecommerce is very much in its infancy – essentially no more than 5 years old, despite older studies into related phenomena such as home shopping. The take-off in interest in the field has come with the arrival of Internet technologies. So far, the state of the art is largely speculation about how to do the research. Telework research is a little more mature, reflecting its longer history as a practical proposition. Research into the transport effects of other tele-applications, such as tele- or e-learning, telemedicine and online administrations, is pretty much non-existent.

We have observed that assessments of the wider picture often suffer from philosophic as well as evidential weakness. These are mostly of the “post hoc ergo propter hoc” variety. Because travel and telecommunications have both been on the increase, it is assumed that their increases are necessarily causally connected. This needs to be demonstrated.

Increases in travel and telecommunications can historically be identified as functions of economic growth and increased levels of prosperity. What is needed is to establish the ways in which they are linked. This cannot be done using broad-brush approaches that see ICT as a singular entity. “ICT” encompasses a wide range of applications, and researchers need to unbundle the concept in order to research the wider picture.

This has happened to some in the field of work patterns, in assessing the impacts of telecommuting, where there is now a large amount of evidence showing that the *direct* effect of telecommuting is to reduce the travel undertaken by individuals. It is not enough to surmise that their, or other people’s, use of other ICT applications could lead to an increase in other travel, and then guesstimate several percentage points to knock off the savings by as a notional counterweight.

What is needed is an identification of discrete areas where empirical data can similarly be gathered – we suggest a breakdown of areas and research tasks in the table and paragraphs below.

The table outlines a suggested initial segmentation of activities that may be helpful for identifying the areas where practical primary research can be undertaken:

**Table 3: First steps to unbundling the concept of ICT**

<b>Area</b>	<b>Application</b>
Telework	<ul style="list-style-type: none"> <li>• Home-based</li> <li>• Centre-based</li> <li>• Mobile/nomadic</li> <li>• Online collaboration</li> <li>• Remote monitoring and diagnostics</li> </ul>

Ebusiness & ecommerce	<ul style="list-style-type: none"> <li>• Supply chain</li> <li>• Logistics</li> <li>• Business-to-business ecommerce</li> <li>• Business-to-consumer ecommerce</li> <li>• Dematerialisation of product</li> </ul>
Electronic service delivery	<ul style="list-style-type: none"> <li>• Elearning</li> <li>• Telemedicine</li> <li>• Egovernment</li> <li>• Eleisure &amp; online media</li> </ul>

In each of these areas, evidence needs to be gathered to answer the questions:

- What travel has been substituted, *as a result of this ICT-enabled application?*
- What travel has been generated, *as a result of this ICT-enabled application?*
- How has travel behaviour been altered in other ways (e.g. change in timing of trips, *as a result of this ICT-enabled application?*)
- Can any linkages be demonstrated between uses of different ICT applications in relation to travel behaviour? (e.g., can it be shown that use of the Internet for e-leisure purposes leads to more or less recreational travel, *and* that teleworkers are more likely to use e-leisure applications, etc)
- What is the incidence of each application – numbers of people using it, frequency of use, timing of use – and what are the growth trends and limits to growth?
- Are there any specific characteristics of the user profile which relate to intensity or likelihood of usage – e.g. location, gender, socio-occupational categories, sector of work, age, usual transport mode(s) etc?
- Are there specific features of the technologies and the level of access (e.g. broadband, ISDN, etc) that influence usage and travel behaviour?
- In the case of organisational uptake, are there any specific characteristics which relate to intensity or likelihood of uptake (sector, type of service/product delivered, location, etc)

The importance of this is that while gaining a “big picture” view of the relationship between telecommunications and travel may be academically interesting, at a policy level it is no help at all.

For example, if it can be shown that telework has a net impact of reducing travel, appropriate policies need to be developed to encourage it. It would be a missed opportunity if it were to be neglected or even constrained, because other ICT applications are believed to have a different effect. Appropriate policies need to be developed for each application.

This “unbundling” approach is also important when analysing practices within a particular field of ICT application. For example, most of the studies we have reviewed on the transport effects of ecommerce have to some extent hedged their bets, saying, “if ecommerce is organised like *this*, it will have *these* effects, but if it is organised like *that*, it will have *those* effects”. At present, these kinds of statement are not very helpful. But after research has established what “these” and “those” effects are, the different models of practice become very significant for developing targeted policies. Research, for example, may identify the value or otherwise of having community distribution points to enable B2C ecommerce<sup>70</sup>.

Unbundling the picture should also enable policies to tackle any negative side-effects of particular applications.

The following sections raise some further research issues for each of the ICT-enabled areas of activity.

#### 4.11.1 Telework

It is evident that two of the areas of telework research have received most of the attention in recent years. It is interesting that the areas not so well covered – mobile/nomadic, online collaboration and remote monitoring/diagnostics – all relate more to in-work (business) travel than the commute journey. Within these there is considerable scope for practical research projects relating ICT application usage to travel behaviour.

One of the commonest problems with teleworking research is to see telework in terms of whole jobs, and to see individual people as teleworkers or not. As most telework has been shown to be part-time, telework should be seen as a work style related to different kinds of tasks. This is an important factor for research. For example, in looking to identify the wider effects of home-based telework researchers have focused on the scope for additional non-work related travel. But for a full understanding of an individual’s travel behaviour it should be recognised that he or she may also be a user of other ICT-related applications that influence their travel options and behaviour. It is by building up the picture in manageable components that an overall picture can be developed.

In terms of “online collaboration”, there have been a few studies of videoconferencing (of the studio rather than desktop variety), but there are numerous other forms of online collaboration which can have an effect on business mileage. It is recommended within the Travel Planning literature, for example, that online collaboration be used to replace meetings. Though it might prove difficult, this is in principle measurable, especially where organisations have taken the step of identifying it as a goal within targets for business travel reduction.

Electronic outsourcing is also being recommended by an array of government departments and agencies (DTI, RDAs, etc). Clients and contractors (and customers) liaising via ICT is the result, and transport movements will be taking place in different areas

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<sup>70</sup> as put forward by a number of studies, e.g. Hopkinson & James: *Virtual Traffic - Will E-business mean less transport and more sustainable logistics?*, 2000

The transport effects of remote monitoring and diagnostics – such as use of CCTV or intelligent components – can also be measured, in principle, if the travel-based service it replaces or supplements can be identified.

In all these areas there is the potential for studies at both the micro and macro levels. Initially, not least to gain a better understanding of the phenomena being studied, research at the micro level is essential.

Where case study work has been done so far, there are sometimes doubts about the quality of the work. There are also difficulties with the comparability of the results. For this reason, we suggest that the Department develops a template approach to gathering case study evidence, based on its priorities for data collection. This would enable data to be gathered from a variety of sources in a consistent manner.

To provide useful data for assessing the longer term locational impacts related to teleworking, longitudinal studies are essential (and have been recommended by most previous commentators). These could look at a particular kind of ICT usage, or a basket of applications, but also needs to be studied in the wider context of the range of factors that affect locational decisions (e.g. schooling, other household members work, house prices, etc).

#### *4.11.2 Ebusiness and ecommerce*

There is a profound need for robust data in the areas of ebusiness and ecommerce.

In the literature reviewed there is substantial consideration of the use of ICT for greater efficiency in the supply chain and logistics. Improvements to (e)business processes are found to generate measurable efficiencies, but the impacts on the road is inferred. Further case study work is needed to establish what happens in practice to the number of trips and vehicle miles travelled as a result of these efficiencies. Particular lower-level applications (such as the use of EDI, Intranets, email etc) should be studied to gain in-depth understanding of their role in reducing, generating, displacing or just organising physical transport.

At the delivery end of ecommerce processes there remains great uncertainty about the future. Projected transport impacts, in the minds of researchers, seem to hinge on the ways in which ecommerce is implemented – by retailers, wholesalers, suppliers and logistics providers. To gain meaningful insights into the effects, a range of different implementations need to be put under the microscope.

Research needs to establish whether particular models have particular transport effects, whether the type of product or classes of products make a difference, and the extent to which physical location of both buyer and vendor makes a difference.

How consumer shopping behaviour is or will be affected is also connected to the type of implementation. Numerous commentators outline different models (revolving around forms of home delivery, workplace delivery, pick-up points, etc). Assertions about what kinds of goods consumers will most readily be willing to buy online, and for what reasons, needs to be tested by research. In addition, it is important to find out how ecommerce shopping behaviour evolves once consumers take the plunge, and whether it changes with time, leading to different kinds of interaction with travel behaviour. There are also important psychological and sociological factors that contribute to a willingness

(or otherwise) to enter into online transactions – these can be researched both through quantitative and qualitative surveys.

In the area of product dematerialisation there has been little research. The case study approach has merit, but again would be enhanced by proposing mechanisms for consistency in approach.

In all these areas there is need for both longitudinal studies, and for broader monitoring of the field as new applications evolve and the market matures.

Research is also needed into the effects of these applications on land use. As well as a possible contributor to urban sprawl, the land use needs of retailers and distributors may change significantly according to several of the scenarios outlined in the literature.

#### *4.11.3 Electronic service delivery (ESD)*

It is also the case that there has been very little research into the transport effects of the range of ESD applications. Government-backed research investment in this field has been exclusively directed at developing the services. The wider societal and environmental consequences of this investment need to be assessed. There is very substantial investment in particular in the e-government and e-learning agenda at the current time: implemented projects are likely to have effects on the travel behaviour of consumers of public services.

Many aspects of this area have similar considerations as for ecommerce. Case study approaches again are appropriate. The kinds of services used, the profile of people using them, how use relates to location, and growth trends as services mature all need to be monitored and measured. Relating this growth to particular travel behaviour is a challenging area requiring an understanding of how groups of people with and without online access to services compare in their travel behaviour.

Access to online services is also tipped as a possible contributor to urban sprawl, as with ecommerce. Different considerations apply in how they affect patterns of land use, compared to ecommerce, as in most instances physical products are not being transported. Products are typically knowledge-based, accessible in the home or accessed at specialist centres (such as learning centres or specialist local clinics). For the supplier of these online services there may be land use implications – typically centralising some activities for online distribution, and decentralising or relocating others to local centres and one-stop-shops.

Online leisure and media may have a variety of effects, as per the other e-services and ecommerce. This covers areas such as access to entertainment over the Internet – music, video and online gaming, for example – and other services such as online newspapers, journals, books and art. All of these have the capacity to affect the nature and quantity of discretionary travel. Clearly some existing (especially broadband) applications are intended to encourage trips – movie trailers, for example. This kind of effect may change over time if whole films become viewable online. New applications may displace other screen activities – such as watching TV – rather than replacing previous physical journeys. There are many fruitful areas here for investigation at both the micro and macro levels.

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## 4.12 Opportunities for research

Little government-backed research into the transport effects of ICT has taken place since 1997. At the same time, the government has been supporting innovations in the use of ICT – the e-government agenda, the e-learning agenda, UK online for business, Wired Communities projects, broadband initiatives and so forth. As well as contributing to some of these initiatives, funding from the DTLR has supported the use of ICT for regeneration activities, and various research and partnership activities, some of which have ICT and travel components. The Department has also actively promoted telework and teleservices through mechanisms such as Travel Plans and travel-to-work initiatives, and in funding for Local Transport Plans (several of which include telework as a traffic demand management measure).

The Department clearly is in need of better information on the impacts of these initiatives on travel and freight distribution. These initiatives have sprung up mostly without clear insight into possible traffic impacts. They also represent many lost opportunities for research activities, but more importantly many new ones.

To take an example: one of the most important e-government implementations recently has been the Employment Services putting all job vacancies they receive online. This is leading to the phasing out of the time-honoured vacancies cards in job centres, and their replacement in job centres with online information. More importantly, from a transport (and social inclusion) point of view, the information is now available “everywhere” via the Internet. Trips to the job centre are no longer a prerequisite for finding vacancy information. The first implementation of Employment Service jobs information online was in Fife (an area suffering from high unemployment) through the Fife Direct project, awarded central government Beacon status by the DTLR in 2001. On the assumption that most people seeking jobs would not have Internet access, 43 “Community Network” access points were set up throughout the region. The monitored high usage of these for accessing online vacancy information and the high use of the call centre set up to deal with follow-up enquiries implies that many trips to the region’s 6 job centres were substituted with many more local trips to network points. This kind of project – and many comparable community-based facilities are being set up throughout the country – has the potential to monitor the travel effects of online services. There are clear opportunities here to research the effects both of more mature projects and of new ones from their inception. There are similar opportunities with the setting up of e-learning initiatives, with the establishment of ICT Learning Centres, grids for learning etc. Every aspect of ICT Learning Centre use seems to be monitored except the kind of information that most help quantify the transport effects.

In the studies we have evaluated we found little in the way of assessing how access to ICT – what kind of ICT, and what speed of connection – influences consumer behaviour or behaviour in the (virtual) workplace. A weakness of many studies seems to be an assumption that if you have a computer and telecommunications all the options are open. This is clearly not the case: issues such as pricing, level, quality and reliability of service, etc, are very important. Hopkinson and James<sup>71</sup> suggest a quantitative

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<sup>71</sup> Hopkinson, P & James, P: *Virtual Traffic - Will E-business Mean Less Transport and More Sustainable Logistics?*, 2000

threshold for the take-off of B2C e-commerce (when uptake reaches a certain level), which will trigger major changes in distribution patterns. It may also be the case that there is a qualitative threshold, where online activities become a more natural thing to do. One opportunity for taking a more sophisticated approach to these kind of issues would be in monitoring online and transport activity in the DFES Wired Communities projects, where large numbers of people are being “wired up” for various levels and types of broadband connection. As well as the seven communities involved, there are comparable initiatives outside the project in Nottingham and Humberside, and no doubt others in the pipeline. These are ideal opportunities for researching the ICT-transport interface.

The promotion of Travel Plans and other travel-to-work initiatives present opportunities for further study of the transport effects of telework. This represents an opportunity to undertake wider and more consistent case study work, enabling in particular the acquisition of a broader range of information about different sectors, workstyles, locational factors, and the impacts of teleworking on other modes.

These are just examples of how current and forthcoming initiatives can be used by the department. There are no doubt many more. The important thing is for the Department to keep abreast with the range of initiatives, and to have the opportunity to build in the necessary research and monitoring.

## 5 CONCLUSIONS

Part of the brief for this project was to be decisive in our approach to the value of the literature, and not to sit on the fence. Broadly speaking, this may have led us to place a higher value on works that have a quantitative element and are based on primary research. We have however noted weaknesses in the data and methodologies as appropriate.

We hope we have not been unduly severe on the more conjectural works. But we see less value in works where conjecture, however apparently sensible, is not supported by significant data or is inferred from data intended for other purposes. These conjectural and secondary works do often highlight areas where information is lacking, and taking a robust approach to their limitations helps to pinpoint research needs. It also hopefully will prevent any tendency to make do with second-best information sources and methodologies. This is particularly important when considering the transferability of research approaches to the DTLR’s current needs.

In summary our conclusions, based on the findings from the literature and our analysis of them, are as follows:

### ***On the travel impacts of telework:***

- The direct transport substitution effects of home-based and centre-based teleworking have been repeatedly measured in the literature, showing statistically significant reductions in travel
- Other forms of teleworking – mobile/nomadic, online collaboration and remote monitoring/diagnostics – have been insufficiently researched to draw firm

conclusions. Some studies of mobile teleworking indicate significant travel savings, primarily through the elimination of commute journeys

- Studies of the complementary or travel generation effects of telework mostly rely on speculation when it comes to attributing new trips. The few studies which measure additional trips by teleworkers in implemented schemes do not find that these trips eliminate the travel savings. However, these studies generally do not include trips made by other household members
- Studies that aggregate transport effects to a national level generally fail to convince. Much more work needs to be done to gather the base data for this kind of exercise.
- The “substitution versus complementarity debate” is unresolved. Data on the “substitution” side is generally balanced by informed conjecture on the “complementarity” side. An American school of researchers, however, appears to have decided in favour of complementarity. Though crucial to the validity of certain traffic reduction policies, to some extent the debate can be a touch facile. Either way, there are significant transport effects that research and policy need to get to grips with. Complementarity implies redistribution of travel, and the new journeys and new locations of activities are important issues for transport research.

**On the transport impact of ebusiness and ecommerce:**

- Research in these areas is under-developed in comparison to the research into teleworking – but in fairness, this is a field of study in its infancy.
- Research tends to focus on different models or scenarios for both business-to-business interactions and for business-to-consumer ecommerce. Research needs to test the validity of these models.
- Some research tends to indicate that increasing efficiency will absorb much of any increase in freight movements, though most commentators expect increases in vans delivering to consumers. Some studies adopting speculative approaches anticipate savings of up to 18% in HGV movements. This is an area lacking in observed data, but as implemented ecommerce schemes mature, there is scope for research into the transport effects. This is, however, a very commercially sensitive area.
- There is a considerable literature on the use of ICT in supply chains and for improving the efficiency of logistics and transport systems. Sometimes statements about possible traffic volume effects may be included, sometimes inappropriately. This literature for the most part does not deal with the core interests of this project. In volume, however, it dwarfs the research in our field of study. The disparity does, however, reflect the research priorities of both the private and public sectors when looking at ICT and transport.
- There is no consensus on the implications for passenger travel. The principle of ecommerce implies fewer trips. But there is no data as yet to show if this is the case. Some studies adopting speculative approaches anticipating savings of 10% or more.
- Research possibly exaggerates the innovative aspects of consumer ecommerce, much of which can arguably be considered a subset of home shopping alongside catalogue shopping and TV shopping.
- There is little research into the transport impacts of “dematerialising” goods and services. This is an important area for future research.

**On the impacts of teleservices:**

- Approaches to the range of ICT “teleservices” (beyond home shopping) are almost entirely confined to the speculative.
- One study projects a 20% reduction in social trips between 1996 and 2010. Mostly, however, use of teleservices is identified as an unquantified trip-generation factor weighing against reductions achieved through teleworking.
- The impact of teleservices, and a “networked society” receives more attention in spatial studies. These are invariably of a speculative nature, and suggest teleservices will be a factor in making households more footloose, and will contribute to urban sprawl or contribute to “hypermobility”. Some more ambitious speculative studies propose new paradigms for spatial planning by mapping the geography of “cyberspace” or “hyperspace”. These studies tend to be bound together by disparate data (where there is any at all) and very cerebral

approaches, although they do propose some innovative concepts that may prove useful.

- Much more data is needed on the transport impacts of online services in the fields of healthcare, government, learning and leisure before further conclusions can be drawn.

***General issues:***

- Transport-focused analyses of ICT use tend to take an undifferentiated or simplistic approach to ICT-based activities. Business or technology-focused studies tend to do likewise in terms of transport. There is fertile ground here for both inter-disciplinary approaches and for greater intellectual rigour in designing research methodologies.

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## 6 RECOMMENDATIONS

One of the main aims of the project is to highlight the future research needs of the DTLR in terms of the relationship between ICT, travel and freight distribution. For this, the Department needs a clear picture of the issues, the state of the art, and its priorities for the future. We hope this report has outlined the major issues in the research and the current state of the art.

The following recommendations are designed to help the Department forward in improving their understanding of this complex field, deciding research priorities, supporting modelling activities and developing “information age” transport policy.

- Considerable research needs to be undertaken in all the areas we have outlined to reduce the uncertainty that pervades the field. Clearly this cannot be undertaken by the DTLR alone. The DTLR should decide which areas of research it wishes to support directly (through existing programmes or new programmes), and which to develop in partnership with other bodies (e.g. other government departments, academic bodies, the European Commission)
- As a first step, the DTLR should develop a research framework indicating its priorities in each of the ICT-related areas. Areas requiring an interdisciplinary and/or inter-departmental approach should be noted and approaches made to relevant partners for joint priority activities
- The emphasis in new research should be in gathering data from practical implementation, rather than further theoretical studies
- In general, new research should avoid research into vast and undifferentiated categories such as “ICT use”, but should focus on a more detailed understanding of the transport effects of particular applications, along the lines of the segmentation outlined in section 4.11. Such an approach can be used, stage by stage, to build up a more robust picture of the impacts of ICT, which can in due course be pulled together into more integrated studies
- There is a clear case for exploring how the “no travel” option can be included as a travel mode into transport models. Further research should be undertaken to explore the implications of this, in terms of the data requirements and variables that need to be considered
- Research methods and findings in this field should be integrated into the mainstream of transport research, and not be allowed to pursue a separate furrow in the margins.
- With issues such as new trip generation from telework, ICT use and urban sprawl (etc) research needs to be closely aligned with parallel research into the complementary effects of other modes (public transport, cycling, car-share, walking)
- The DTLR should track the development of the range of ICT initiatives, in particular those promoted by other parts of the government and agencies such as local authorities and RDAs with which it has a close connection. This is in part to ensure that ICT initiatives where possible take account of transport issues, and include parameters in their monitoring which can provide useful transport-related

information, and in part to enable DTLR-supported research to be included in the initiatives where appropriate.

With a greater understanding of the impacts of ICT on travel behaviour and freight distribution, the Department will be in a stronger position to develop the range of policies that are appropriate to the 21<sup>st</sup> century, and that relate closely to the government's emphasis on promoting the UK as an "Information Society".

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## 7 APPENDICES

### 7.1 Appendix 1 - List of studies entered in the database as full reviews

**Title:** The Impacts of Teleworking - A Study of AA Employees

**Authors:** Hopkinson, P, James, P, Mayurama, T, & Selwyn, J

**Reference:** , 2001

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** The paper from Bradford University and UKCEED summarises a survey of 103 AA call centre staff who moved from office-based to home-based working in the summer of 2000.

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**Title:** The BT Options 2000 – A Pilot Study of its Environmental and Social Impact

**Authors:** Hopkinson, P. & James, P.

**Reference:** [www.workingfromhome.co.uk/wfh/information\\_zone/in\\_the\\_news/newszzb.htm](http://www.workingfromhome.co.uk/wfh/information_zone/in_the_news/newszzb.htm), 2001

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** This study is an examination of the impact that e-commerce has on the travel habits of BT staff and environmental and social impacts.

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**Title:** **Opportunity for Action**  
*Supply Chain Strategies for the Internet Era*

**Authors:** Keevil C., Dickel K. and Christodouleas J.

**Reference:** Boston Consulting Group  
[www.bcg.com/publications/search\\_view\\_ofas.asp?pubID=631](http://www.bcg.com/publications/search_view_ofas.asp?pubID=631), 2001

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: No, Leisure: No

**Overview:** This article presents case studies of companies that are using selected Internet strategies to rebuild their supply chains through:

- actively collaborating with supply chain partners;
- extending the company's reach, up and down the supply chain;
- changing the supply chain flow path;
- growing revenue; and
- transforming capabilities into new businesses.

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**Title:** **Impacts of Information and Communication Technology on Urban Logistics System**  
*The Impact of E-Commerce on Transport – Transport and Local Distribution*

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**Authors:** Nemeto T., Visser J. and Yoshimoto R.

**Reference:** OECD Joint Seminar, Paris 5/6 June 2001 [www.oecd.org/pdf/M00021000/M00021691.pdf](http://www.oecd.org/pdf/M00021000/M00021691.pdf), 2001

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: No, Leisure: No

**Overview:** This paper was presented at a seminar on transport and local distribution to the European Conference of Ministers of Transport and the Organisation for Economic Co-operation and Development. It proposes possible impacts of ICT on behaviour and urban logistics, based on 10 assumptions of influences and effects brought about by ICT.

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**Title:** **Emerging Trends and Hindrances for E-Logistics. An Australian Perspective in 2001**  
*The Impact of E-Commerce on Transport – E-Commerce and Logistics*

**Authors:** Hassall, K

**Reference:** OECD Joint Seminar, Paris 5/6 June 2001 [www.oecd.org/pdf/M00021000/M00021667.pdf](http://www.oecd.org/pdf/M00021000/M00021667.pdf), 2001

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: No, Leisure: No

**Overview:** This paper was presented at a seminar on transport and local distribution to the European Conference of Ministers of Transport and the Organisation for Economic Co-operation and Development. It looks at changes e-commerce demands from traditional supply chains, using case studies in Australia to highlight specific effects.

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**Title:** **E-business Impacts on the Transport System**  
*(series of working papers)*

**Authors:** Smith, N., Ferreira, L. & Mead, E.

**Reference:** <http://www.nts.gov.au/media.htm#ebusinesspapers>, 2001

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: Yes, Leisure: Yes

**Overview:** This is a series of 9 working papers on the subject of the impact of e-business on transport in Australia, prepared for the National Transport Secretariat of Australia

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**Title:** **E-Commerce and Logistics**  
*The impact of e-commerce on logistics - paper presented at Joint OECD/ECMT seminar on the Impact of E-commerce on transport, June 2001*

**Authors:** Colin, J.

**Reference:** [www1.oecd.org/cem/online/ecom01/](http://www1.oecd.org/cem/online/ecom01/), 2001

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No

**Overview:** This presentation from Jacques Colin, of the Université de la Méditerranée, at an OECD seminar defines the different types of e-commerce activity, examines current trends and anticipates the impacts on transport logistics in the coming years.

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**Title:** **Impacts of Information Technology on Personal Travel and Commercial Vehicle Operations: Research challenges and opportunities.**  
*Exploring some of the effects of IT on transportation, both personal and freight.*

**Authors:** Golob, T. F. and Regan A.C.

**Reference:** Transport Research Part C 9 (2001) 87-121 [www.elsevier.com/locate/trc](http://www.elsevier.com/locate/trc), 2001

**Travel issues:** Commuting: Yes, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No

**Overview:** This paper looks at the growth of the internet and discusses ITS implications for transportation. Virtual accessibility leads to a redefinition of access outside terms of travel time, distance or generalised travel cost. Effects of e-commerce on freight movements, shipment sizes and delivery procedures are discussed.

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**Title:** **E-Commerce, Freight Distribution and the Truck Industry**  
*Discussion Paper – 4th ACEA (Association des Constructeurs Européens d'Automobiles) Scientific Advisory Group Meeting*

**Authors:** Browne M.

**Reference:** [www.acea.be/acea/publications.html](http://www.acea.be/acea/publications.html), 2001

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: No, Leisure: No

**Overview:** This discussion paper is the fourth in a series examining issues relating to freight transport and commercial vehicles. It briefly charts the progress of business-to-business and business-to-consumer e-commerce and describes the potential effects on company logistics. Commercial vehicle users' requirements are discussed as are policy implications.

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**Title:** **Motors and Modems Revisited: The role of Technology in Reducing Travel Demands and Traffic Congestion**

**Authors:** Dodgson, J., Pacey, J. & Begg, M.

**Reference:** [www.nera.com](http://www.nera.com), 2000

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: Yes, Shopping: Yes, Leisure: Yes

**Overview:** The research looks at the potential future impact of teleworking, teleshopping, teleconferencing and other IT applications on road traffic in the UK up to the year 2010. It updates an earlier report in 1997 (*Motors and Modems*)

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**Title:** **Issues and Recommendations For E-Commerce Impacts on Urban CVO (Commercial Vehicle Operations) Deliveries and Parking (2000 ITSC Proceedings)**

**Authors:** Easley, R.B. & Easley, S.C.

**Reference:** , 2000

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No

**Overview:** This research paper examines the impact of e-commerce upon urban deliveries in the United States, in terms of congestion, logistics strategies etc.

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**Title:** Case Studies of the Information Society and Sustainable Development

**Authors:** Forseback, L.

**Reference:** European Commission, Information Society Directorate-General Unit C1[www.forseback.se/pdf/case\\_infosoc.pdf](http://www.forseback.se/pdf/case_infosoc.pdf), 2000

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: Yes, Shopping: Yes, Leisure: Yes

**Overview:** This work is a collection of case studies illustrating the diverse ways in which ICT can contribute to sustainable development. Case studies are classified under the broad categories of

- Dematerialisation: sustainable services
- Sustainable mobility, and
- New jobs and methods of work

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**Title:** A Framework for the Analysis of Grocery Shopping

**Authors:** Marker J. and Goulias K.

**Reference:** 79th Annual Meeting of the Transportation Research Board, January 9-13, Washington, DC., 2000

**Travel issues:** Commuting: Yes, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No

**Overview:** This paper examines how teleshopping might impact on transportation. A methodology for modelling consumer behaviour towards household replenishment is given.

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**Title:** Electronic Grocery Shopping and its Impact on Transportation & Logistics with Special Reference to Finland

**Authors:** Kilpala H., Seneviratne P. and Pekkarinen S.

**Reference:** 79th Annual Meeting of the Transportation Research Board, January 9-13, Washington, DC., 2000

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: Yes, Leisure: No

**Overview:** This paper looks at the impact of e-commerce on transportation in Finland, with its sparse population. A theoretical model for evaluating impacts is described.

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**Title:** Telecommunications and Travel

**Authors:** Mokhtarian, P. L..

**Reference:** Transportation Research Board,; A1C08: Committee on Telecommunications and Travel, Jan 2000[www.nationalacademies.org/trb/publications/millennium/00115.pdf](http://www.nationalacademies.org/trb/publications/millennium/00115.pdf), 2000

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**Travel issues:** Commuting: Yes, In-business: Yes, Freight: Yes, Shopping: Yes, Leisure: Yes

**Overview:** This article provides a discourse on the relationship between telecommunications and travel, summarising the major strands of research and indicating future directions for research.

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**Title:** **Asking the Right Questions about Telecommuting: Avoiding Pitfalls in Surveying Home-based Work**

**Authors:** Pratt, J.H.

**Reference:** Transportation 27: pp99-116 2000, 2000

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper has a practical focus in providing insights into how to gather meaningful data in surveys of home-based (tele-)work. In doing so, a critique is also provided of existing surveys.

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**Title:** **Virtual Traffic - Will E-business Mean Less Transport and More Sustainable Logistics?**  
*(Part of the Digital Futures Project)*

**Authors:** Hopkinson, P. & James, P.

**Reference:** [www.digitalfutures.org.uk](http://www.digitalfutures.org.uk), 2000

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No

**Overview:** This study examines the pros and cons in terms of sustainability of moves towards e-business. It examines the evidence on either side of a debate which it styles as the 'quieter roads and fuller baskets' scenario versus the 'e-road rage' scenario

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**Title:** **Possible Impacts Of Telework On Commute Travels In The Turin Metropolitan Area**  
*Using Council Workers to Depict Teleworking Scenarios*

**Authors:** Diana M. and Villa M

**Reference:** , 2000

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** Teleworking is not established in Italy. This paper looks at possible impacts should teleworking be introduced. The investigation was of 185 council employees in Turin who are potential teleworkers.

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**Title:** **Interpreting Employee Telecommuting Adoption: an Economics Perspective**

**Authors:** Yen, J-R

**Reference:** Transportation 27 pp149-164, 2000

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

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**Overview:** This study takes an economic approach to analysing the demand for telecommuting amongst employees and identifying the variables which are most important in stimulating or constraining the choice to telecommute.

**Title:** **New Telecommunications and Residential Location Flexibility**

**Authors:** Shen, Q

**Reference:** Transportation Research Board 79th Annual meeting, January 2000, 2000

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** The paper develops an analytical framework for understanding changes in residential location flexibility created by new telecommunications technologies. The framework is then applied to an exploration of changing spatial structures under alternative scenarios in a hypothetical metropolitan setting.

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**Title:** **White van gridlock or a boon for traffic reduction – how will E-Commerce affect transport?**

**Authors:** Millard-Bell, Adam

**Reference:** Local Transport Today 297, 31.8.00., 2000

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No

**Overview:** The article is concerned about how e-commerce activities (through home shopping) have altered personal and freight distribution patterns. The core question asked was whether there were less cars on the road as a result of fewer shopping trips being made or just simply more white van movements to service customer needs.

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**Title:** **TravelBehavior.com**  
*Activity Approaches to Modeling the Effects of Information Technology on Personal Travel Behavior*

**Authors:** Golob, T. F.

**Reference:** A Resource Paper for IATBR 2000, 9th Conference of the International Association for Travel Behavior Research Gold Coast, Queensland, Australia 2-7 July, 2000 [www.its.uci.edu/its/publications/papers/AS-WP-00-1.pdf](http://www.its.uci.edu/its/publications/papers/AS-WP-00-1.pdf), 2000

**Travel issues:** Commuting: Yes, In-business: No, Freight: Yes, Shopping: Yes, Leisure: Yes

**Overview:** This paper puts forward ideas for extending travel behaviour modelling to account for interactions between travel and telecommunications. It outlines the rise of ICT and of applications such as telework, ecommerce and e-services, and reviews the literature examining their potential effects on transport. The recommendations put forward a research framework for modelling and the areas for improved data collection.

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**Title:** **Forecasting and Assessing the Mobility Effects of Teleservice Using a Scenario Approach**

**Authors:** Martens M. and Korver W.

**Reference:** 79th Annual Meeting of the Transportation Research Board, January 9-13, Washington, DC., 2000

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

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**Overview:** This paper describes factors which influence the decision to telecommute and uses scenarios from the Dutch National Planning Agency to estimate the effect of different variables on numbers of trips and trip kilometres.

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**Title:** **The Social Implications of Hypermobility**  
*Speculations about the social consequences of the OECD Scenarios for Environmentally Sustainable Transport and Business-as-Usual Trend Projections*

**Authors:** Adams, J.

**Reference:** [www.oecd.org/env/ccst/est](http://www.oecd.org/env/ccst/est), 1999

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** The term *hypermobility* is used by the author to suggest that it may be possible to have too much of a good thing. The essay provides a starting point for evaluating the social costs and benefits of the scenarios developed in the OECD Environmentally Sustainable Transport project

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**Title:** **Information Technology for Sustainable Societies – Public Policy Perspectives in Japan: The Case of Telework**

**Authors:** Mitomo, H. & Oniki, H.

**Reference:** The IPTS Report, no 32 March 1999 [www.jrc.es/pages/f-report.en.html](http://www.jrc.es/pages/f-report.en.html), 1999

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** This article looks at the potential for IT applications, particularly telework, to contribute to Japan's commitment to reduce its greenhouse gases by 6% by 2008 from 1990 levels.

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**Title:** **Integrated Telematics Applications in Road Freight Transport: Final Results of the European 4th Framework Programme Project INTACT**

**Authors:** Jorna, R. & van Drunen, E.

**Reference:** , 1999

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: No, Leisure: No

**Overview:** The INTACT project provides an analysis of the integration of telematics into road freight operations and the potential benefits that can be derived from such an activity.

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**Title:** **The Environmental Impact of Teleworking**

**Authors:** Hopkinson, P. James, P. & Selwyn, J.

**Reference:** Proceedings of the Telework Assembly, Aarhus, 1999 [www.eto.org.uk/twork/aarhus99/aarhusmain.pdf](http://www.eto.org.uk/twork/aarhus99/aarhusmain.pdf), 1999

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** This paper presented at the Aarhus Assembly on Telework, provides an overview of studies into the environmental impacts of telework.

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studies into the environmental impacts of telework.

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**Title:** **The Sustainable Network Society – A Scenario Study of Transport and Communications**

**Authors:** Snickars, F.

**Reference:** In East West Perspectives on 21st Century urban Development: Sustainable Eastern and Western Cities in the New Millennium, Ed John Brotchie, Peter Newton, Peter Hall and John Dickey. Ashgate Publishing Ltd, 1999

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: Yes, Shopping: Yes, Leisure: Yes

**Overview:** This paper, by Prof Folke Snickars of the Regional Planning Institute, Royal Institute of Technology in Sweden reports and reflects on the findings of a futures study surveying the views of transport professionals. It examines the relationship between transport, communications and long-term environmental sustainability.

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**Title:** **The Transportation Impacts of Center-Based Telecommuting: Interim Findings from the Neighborhood Telecenters Project**

**Authors:** Balepur, P.N., Varma, K.V. & Mokhtarian, P.L

**Reference:** Transportation 25(3), 1998, 287-306, 1998

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** The paper analyses the transportation impacts of center-based telecommuting for 24 participants (representing 69 person-days of travel and 295 trips) in the California Neighborhood Telecenters Project.

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**Title:** **ENTRANCE Energy Savings in Transport Through Innovations in the Cities of Europe**  
*Monitoring and Evaluation of the Applications in Hampshire, UK Teleworking Trial*

**Authors:** Lyons G.D

**Reference:** TRL, 1998

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** This is a before and after study of a teleworking trial as part of the ENTRANCE project. Effects of introducing teleworking to staff are compared to their prior expectations and the experience of established teleworkers. Travel diaries and vehicle log data were collected.

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**Title:** **Telecommuting: The Shortest Route to Work**

**Authors:** Amarach Consulting for Dublin Transportation Office

**Reference:** Government Stationery Office, ISBN 0-7076-6744-5, 1998

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

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**Overview:** *Telecommuting: The Shortest Route to Work* examines the potential for telecommuting to contribute to traffic reduction objectives in the Dublin Transportation Area.

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**Title:** **Beyond Tele-substitution: A Broader Empirical Look at Communication Impacts**

**Authors:** Mokhtarian, P.L. & Meenakshisundaram, R.

**Reference:** California PATH Working Paper UCB-ITS-PWP-98-33 <http://www-path.eecs.berkeley.edu/PATH/Publications/PATH/PWP-98-33.pdf>, 1998

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** The study analyses the interplay between ICT-based communication and transport activities using structural equations modelling. Treating transport as one of 3 types of communications activities, it analyses diary data from two points in time to try to establish relationships between different communications activities, and the influence of other 'exogenous' variables.

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**Title:** **The Duration and Frequency of Telecenter Use: Once a Telecommuter, Always a Telecommuter**

**Authors:** Varma, K.V., Ho, C-I., Stanek, D.M. & Mokhtarian, P.L.

**Reference:** Transportation Research C6(1/2), 1998, 47-68, 1998

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This research examines, in the context of centre-based telecommuting, how often individuals telecommute, the duration of their telecommuting participation, and causes of attrition among telecommuters. It also presents related findings from previous studies of home-based telecommuting

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**Title:** **A Synthetic Approach to Estimating the Impacts of Telecommuting on Travel**

**Authors:** Mokhtarian, P.L.

**Reference:** Urban Studies, vol 35 No.2, 215-241, 1998, 1998

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** The paper proposes a multiplicative model as a framework for examining the current state of knowledge in forecasting the demand for telecommuting and the resulting transportation impacts. In addition, the paper provides an illustrative example containing a base and future case, using data from studies in California.

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**Title:** **The Impact of Gender, Occupation, and Presence of Children on Telecommuting Motivations and Constraints**

**Authors:** Mokhtarian, P.L, Bagley, M.N. & Salomon, I.

**Reference:** Journal of the American Society for Information Science 49(12) [www.fhwa.dot.gov/ohim/womens/chap37.pdf](http://www.fhwa.dot.gov/ohim/womens/chap37.pdf), 1998

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- Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No
- Overview:** In this study, the authors analyse differences in variables due to gender, occupation, and presence of children for 583 employees of the City of San Diego. Numerous differences are identified, which can be used to inform policies (public or organizational) intended to support telecommuting.
- Title:** **Home Delivery – Environmental Solution or Disaster?**
- Authors:** Millar.J and Cairns.S
- Reference:** Proceedings of The Institute of Logistics Conference, British Library, 1998
- Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No
- Overview:** This paper presented at The Institute of Logistics Conference in 1998, addresses the impact of home deliveries upon the environment, in terms of effects on travel patterns.
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- Title:** **The Tradeoff between Trips and Distance Traveled in Analyzing the Emissions Impacts of Center-Based Telecommuting**
- Authors:** Mokhtarian, P.I. & Varma, K.V.
- Reference:** Transportation Research D 3(6), 1998, 419-428, 1998
- Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No
- Overview:** This paper describes one of the first studies of the travel and emissions impacts particularly of center-based telecommuting. Travel diary data comprising 323 person-days and 1,442 person-trips were collected from 72 participants in a telecommuting center demonstration project in California. Six travel indicators were studied: number of person trips, personal vehicle trips, cold starts, hot starts, person-miles traveled, and vehicle-miles traveled
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- Title:** **The Costs and Benefits of Telecommuting: An Evaluation of the Macro-scale Literature**
- Authors:** Shafizadeh, K.R., Niemeier, D.A., Mokhtarian, P.L. & Salomon, I.
- Reference:** Partners for Advanced Transit and highways (PATH) working paper [PATH MOU 278 – Telecommuting Public Investment Study]<http://www.path.berkeley.edu/PATH/Publications/PATH/PWP-98-5.pdf>, 1998
- Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No
- Overview:** This literature review was prepared to synthesize and assess previous evaluations of telecommuting. It proposes a conceptual framework to organize the inputs and outputs of a macro-scale telecommuting benefit-cost analysis. Then, four federal and regional reports are examined in terms of methodology, assumptions, economic approach, and major findings. This review identifies common inputs and discusses the critical assumptions that routinely affect the results. Finally, the economic approaches and major findings are presented and compared
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**Title:** **The Impact of Telecommuting on the Activity Spaces of Participants and their Households**

**Authors:** Saxena, S. & Mokhtarian, P.L.

**Reference:** Geographical Analysis 29(2) (April), 1997, 124-144, 1997

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** A spatial analysis of the activity space of telecommuters and their household members is performed to analyse the impacts of telecommuting. This is seen as important to test often unmeasured assumptions about the knock-on effects of telecommuting on other trips and travel behaviour.

**Title:** **Assessing the Impact of Advanced Telecommunications on Work-related Travel**

**Authors:** Lake, A.S. & van Vuren, T.

**Reference:** DTLR, HOP Associates [www.hop.co.uk](http://www.hop.co.uk), 1997

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** The study seeks to analyse the traffic impacts of increased use of teleworking in a large organisation, Cambridgeshire County Council. The assessment of the amount of time a worker can spend teleworking is based on an analysis of work types. Taking into account both home locations and the locations in which work takes place, the results were put through the Cambridge area transport model run by the County Council, to model the transport effects of a number of scenarios of telework uptake.

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**Title:** **Bringing Home the Bacon**

**Authors:** Chartered Institute of Transport

**Reference:** Pegasus, 1997

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No

**Overview:** This is a short article discussing the issue of home shopping and the impact it has upon distribution operations.

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**Title:** **Shopping Without Travel or Travel Without Shopping?**  
*An Investigation of Electronic Home Shopping*

**Authors:** Gould J. and Golob T.

**Reference:** Transport Reviews Vol. 17, No. 4, 355-376, 1997

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** This paper explores the growth of electronic home shopping in terms of likely transportation and communications interactions. It uses a two-day study of travel activity in a large US metropolitan area to establish a baseline. Comparisons of activities are compared between workers and teleworkers.

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**Title:** **Environmental Flows**

*Telecommunications and the dematerialisation of cities?*

*Telecommunications and the dematerialisation of cities?*

- Authors:** Marvin, S.
- Reference:** Futures 29 no 1 pp47-65, 1997 [www.ncl.ac.uk/cut/publications.html](http://www.ncl.ac.uk/cut/publications.html), 1997
- Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No
- Overview:** This paper explores the relationship between telecommunications systems and urban environmental policy. It challenges the assumption that telecommunications improve the environmental performance of cities because they are 'inherently environmentally benign', 'substitute' for travel, and lead to the dematerialisation of cities. It argues that the environmental implications of telecommunications are much more complex and contradictory than is often assumed.

**Title: Residential Area-Based Offices Project: Final Report on the Evaluation of Impacts**

- Authors:** Mokhtarian, P.L., Ho, C-I., Hung, S.W., Lam, T.B., Raney, E.A., Redmond, L.S., Stanek, D.M., & Varma, K.V.
- Reference:** Research Report UCD-ITS-RR-97-17, University of California at Davis [www.engr.ucdavis.edu/~its/tcenters/repts/final/Title.htm](http://www.engr.ucdavis.edu/~its/tcenters/repts/final/Title.htm), 1997
- Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No
- Overview:** The Residential Area-Based Offices (RABO) Project, sponsored by the Federal Highway Administration and the California Department of Transportation, was designed to evaluate the effectiveness of telecommuting centres as an institutional work arrangement and as a transportation demand management strategy.

**Title: Travel and the Superhighway**  
*Motoring 2010: The end of the road?*

- Authors:** Autoglass
- Reference:** , 1996
- Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: Yes, Leisure: Yes
- Overview:** The report examines 'the extent to which travel by technology will take over from travel by tarmac'. Projections of travel reductions by the year 2010 stemming from use of ICT (the 'superhighway') are put forward, looking at commute travel, social travel and shopping travel.

**Title: Forecasting Telecommuting – An Exploration of Methodologies and Research Needs**

- Authors:** Handy, S.L., & Mokhtarian, P.L
- Reference:** Transportation 23 (2) pp163-190, 1996
- Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No
- Overview:** In this paper the authors address the need to incorporate telecommuting as a transport demand management strategy into transportation forecasts. They explore 4 alternatives methods for forecasting telecommuting and discuss the kinds of data that

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need to be collected before these methodologies can be applied

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**Title:** **The Travel and Emissions Impacts of Telecommuting for the State of California Telecommuting Pilot Project**

**Authors:** Koenig, B.E., Henderson, D.K. & Mokhtarian, P.L.

**Reference:** Transportation Research 4C (1996) pp13-32, 1996

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This is a detailed study of the impact on vehicular emissions generation of participants in the State of California Telecommuting Pilot Project.

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**Title:** **Travel Demand Model System for the Information Era**

**Authors:** Ben-Akiva, M., Bowman, J.L. & Gopinath, D

**Reference:** Transportation 23 (3) 1996 pp241-266, 1996

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** The emergence of new information technologies and advances on existing ones provide new dimensions for travel demand decisions. This paper proposes a comprehensive modelling framework that can be used by decision makers and planners to evaluate the effects of changes in transportation system and developments in new technologies such as telecommuting, teleservices and Intelligent Transportation Systems

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**Title:** **Teleworking – An Overview of the Research**

*A Report to the Department of Transport, Department of the Environment, Department of Trade and Industry, and Department for Education and Employment*

**Authors:** Huws, U

**Reference:** , 1996

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** The purpose of this report was to review existing research on the extent and nature of teleworking and future trends in its development, and to examine the feasibility of carrying out joint research by the government departments that commissioned the study. The report covers transport, environment, trade and industry and employment issues, and issues of data quality.

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**Title:** **Review of Telework in Britain: Implications for Public Policy**

**Authors:** Gillespie A., Richardson R., & Cornford J

**Reference:** Newcastle Programme for Information and Communication Technologies, Centre for Urban and Rural Development Studies, University of Newcastle upon Tyne, 1995

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** This report was prepared for the Parliamentary Office of Science and Technology which examines the nature of telework, potential benefits and disbenefits, and the

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policy implications. It has a chapter focusing on telework, transport and the environment, in which the research in this area is reviewed.

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**Title:** **An Introductory Study of Telework Based Transport-Telecommunications Substitution**  
*A Research Project for the Department of Transport*

**Authors:** Mitchell, H. & Trodd, E.

**Reference:** DTLR, 1994

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** The study was an initial investigation into telework-based transport substitution. It was commissioned by the UK Department of Transport (now DTLR) with the aim of providing an assessment of the potential impact of telework on transport demand, and to suggest directions for future research.

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**Title:** **Telecommuting and Residential Location: Theory and Implications for Commute Travel in the Monocentric Metropolis**

**Authors:** Lund, J.R. & Mokhtarian, P.L.

**Reference:** Transportation Research Record 1463, 1994, 10-14, 1994

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This study examines the assumption that the new flexibilities brought about by telecommuting could encourage residential location farther from the traditional work-place, thereby inducing additional travel on days when the employee travels to the traditional work-place. In the worst case, total commute distance travelled after relocation could be worse than before.

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**Title:** **Beyond Telecommuting: A New Paradigm for the Effect of Telecommunications on Travel**

**Authors:** Niles, J.

**Reference:** US Department of Energy DOE/ER-0626 [www.lbl.gov/ICSD/Niles](http://www.lbl.gov/ICSD/Niles), 1994

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** This report for the US Department of Energy seeks to build on earlier reports that measured travel and emissions reductions due to telecommuting, and look at the wider effects of telecommuting including the stimulation of new trips. Wide-ranging recommendations for government are made.

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**Title:** **Transportation Implications of Telecommuting**

**Authors:** US Department of Transportation

**Reference:** <http://ntl.bts.gov/DOCS/telecommute.html>, 1993

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**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** This is one of the earliest studies of telecommuting by a government agency. It covers briefly the background to the emergence of telecommuting and highlights its implications for public policy. It then looks in detail at transport effects, and possible trends if the uptake of telecommuting is as predicted by contemporary studies.

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**Title:** **Development of New Information Systems for Freight Transport Operations in Europe**

**Authors:** Bollo.D

**Reference:** IATSS Research, Vol.16, No.2., 1992

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: No, Leisure: No

**Overview:** This article from IATSS Research discusses the various information systems used in European freight transport operations, primarily mobile transmission systems, automatic tracking and tracing and telecommunication networks and Electronic Data Interchange (EDI).

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**Title:** **Teleworking in the Netherlands: an evaluation of changes in travel behaviour**

**Authors:** Hamer.R, Kroes, E. & Van Ooststroom, H

**Reference:** Transportation, Vol.18, pp365-382, 1991

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: Yes

**Overview:** This research paper examines the impact of teleworking in the Netherlands upon changes in travel behaviour. It outlines the first experiment on 'teleworking' in the Netherlands, carried out by the Hague Consulting Group on behalf of the Project Bureau for Integrated Transport Studies, in April 1990

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**Title:** **Impact of Telecommuting on Spatial and Temporal Patterns of Household Travel**

**Authors:** Pendyala, R.M, Goulias, K.G. & Kitamura, R.

**Reference:** Transportation 18, 1991, 383-409, 1991

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** The study is a spatial and temporal analysis of travel diary data gathered during the State of California Telecommuting Pilot Project.

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## 7.2 Appendix 2 - List of studies entered in the database as summaries only

**Title:** All Seeing Eye

**Authors:** Brown, A

**Reference:** Motor Transport 2-9/8/01, 2001

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This article is focussed upon the application of ICT upon Sainsbury's distribution operations. The application in question, is a fleet management/track and trace application.

This is a very good case study article on the application of track and tracing to freight distribution. It also discusses in depth the impact that this has upon Sainsbury's operations and future plans. Overall it is a very good article on the subject of the impact of ICT upon freight distribution patterns. No wider impacts on travel patterns are mentioned.

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**Title:** E-Commerce and Consequences for the Logistics Industry

**Authors:** Hultkrantz, O. & Lumsden, K.

**Reference:** OECD Joint Seminar, Paris 5/6 June 2001: The Impact of E-Commerce on Transport [www1.oecd.org/cem/online/ecom01](http://www1.oecd.org/cem/online/ecom01), 2001

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: No, Leisure: No

**Overview:** This paper covers the impacts of ecommerce in the supply chain and looks at issues for distribution. Similar ground is covered to that in the first parts of their longer paper *E-commerce and Logistical Consequences* (2000) which is reviewed in full, but in this study impacts 'on the road' are not analysed.

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**Title:** Analysis of Spatial Planning and Emerging Communications Technologies (ASPECT) – 2nd Interim Synthesis Report

**Authors:** Hughes, G.

**Reference:** [www.region-numerique.org/aspect/](http://www.region-numerique.org/aspect/), 2001

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** This is an interim report of the continuing ASPECT project, which looks at the implications for spatial development and planning of the new ICT. The synthesis report builds on individual regional studies which vary in focus and methodologies.

'Transport and Travel' and 'the Urban-Rural Balance' are identified as key aspects of the project. However, the report does not cover any new ground and does not take a systematic approach to the issues. The findings are mainly speculative, rehearsing familiar themes. It concludes that though change is slower than anticipated, ICT remains important for spatial planning.

**Title:** **STAR Project**  
*Socio-Economic Trends Assessment of the Digital Revolution*

**Authors:** Framework 5 EC Project

**Reference:** [www.databank.it/star/](http://www.databank.it/star/), 2001

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** The STAR project – Socio-Economic Trends Assessment of the Digital Revolution - is focused on the analysis of the development of the Digital Economy in Europe, in order to contribute to a better understanding of the conditions leading to sustainable social and economic growth patterns – how to survive the transition phase.

STAR is an initiative of Key Action II "New Methods of Work and Electronic Commerce", one of four key actions of the User-Friendly Information Society Programme.

Some of the papers contain sharp analysis of current trends and issues, and there will be more as the project continues. The focus, however, is not on transport. But there is useful material for monitoring and understanding developments.

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**Title:** **@ Your Home: New Markets for Customer Service and Delivery**

**Authors:** Retail Logistics Task Force

**Reference:** [www.foresight.gov.uk/servlet/DocViewer/doc=2857](http://www.foresight.gov.uk/servlet/DocViewer/doc=2857), 2001

**Travel issues:** Commuting: No, In-business: No, Freight: Yes, Shopping: Yes, Leisure: No

**Overview:** This report is the product of a study into business to consumer (B2C) home delivery designed to:

- identify the potential UK market for B2C home delivery
- gauge current knowledge about such deliveries
- identify gaps in current understanding of their social, economic and environmental implications, and
- consider future research needs in this area

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**Title:** **Modeling Employees' Perceptions and Proportional Preference of Work Locations: The Regular Workplace and Telecommuting Alternatives**

**Authors:** Mokhtarian, P.L. & Bagley, M.N.

**Reference:** Transportation Research A 34(4), 2000, 223-242, 2000

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper develops measures of job and workplace perceptions, and examines the importance of those and other measures to the desired proportions of work time at each of three locations: regular workplace, home, and telecommuting center.

Using data from 188 participants in the Neighborhood Telecenters Project, four job context perception factors are identified: productivity, job satisfaction, supervisor relationship, and co-worker interaction.

Four generic 'workplace perception factors' were identified (with measures for each of the work locations of interest): personal benefits, work effectiveness, autonomy, and

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supervisor comfort. The study supplements the work of this group of researchers in modelling the incidence of telework.

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**Title:** **New Ways of Working**

**Authors:** Jupp, S.

**Reference:** Hawksmere ISBN: 1 85418 169 6, 2000

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** An important guide to the the implementation of teleworking, but it does not directly address transport.

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**Title:** **Bridging Urban Digital Divides?**  
*Urban Polarization and Information and Communications Technologies (ICTs): Current Trends and Policy Prospects.*

**Authors:** Graham S.

**Reference:** Newcastle University <http://www.ncl.ac.uk/cut/publications.html>, 2000

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper was written as a background paper for the United Nations Centre for Human Settlements. The first part shows that the growth in electronic communications and urbanisation are mutually supportive. ICT is shown to support 'new extremes of social and geographical unevenness within and between human settlements'. The second part shows that ICT might help 'to work against urban polarization through sustained policy intervention which integrates them fully into our development strategies for human settlements.'

The paper does not directly address transport issues. However, its message is important for transport policymakers. If ICT and settlement forms are closely intertwined, then transport planners will need to be aware of patterns in ICT. The impact of ICT has not been uniform and though there are attempts to level this field it is likely that there will always be 'haves' and 'have nots'. Areas where there is no ICT will not be able to take advantage of teleworking or e-commerce and so benefits espoused by other authors of e-business may over estimate their case if they do not allow for this disparity.

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**Title:** **Intermodal and International Freight Network Modeling**

**Authors:** Southworth F. and Peterson B.

**Reference:** Transportation Research Part C, 8, 147-166, 2000

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper describes the development and application of a single, integrated digital representation of a multimodal and transcontinental freight transportation network. The 1997 US Commodity Flow Survey is used as input data for the model. This represents five million origin-destination freight shipments including, commodity type, tonnage, value and mode sequence. GIS technology was used to validate mode sequences and route selections. As noted at the conclusion of this article, the generation of sensible traffic routing options 'provides a good deal of insight into the infrastructure-

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constrained options available for intermodal transportation'. This is a topic of growing importance as the globalisation of trade puts competitive pressures on national economies to increase their freight carrying capacity. A detailed geography of freight transportation networks will make it easier to anticipate as well as understand the need for these new capital investments.'

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**Title:** E-Mobility (Electronic Travel): Measuring New and Evolving Behaviour

**Authors:** Zmud J. and Arce C.

**Reference:** International Association for Travel Behaviour Research, Brisbane, Australia 2-7 July, 2000

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper compares data from the US Postal Service Household Diary Study with several US metropolitan area Household Travel Surveys to assess whether online shopping will mitigate, encourage or have no impact in traditional shopping trips. A general lack of data on the impacts of e-commerce activity led these authors to compare different data sources. They found that shopping is increasing just as the Internet is becoming more widespread. This may be due to a psychological need or because Internet shopping is not as easy as it might be. Further, only 8% of online users spend much time shopping on the Internet. The authors suggest that 'Internet "shopping" may be "browsing" that enhances the volume of traditional shopping travel instead of reducing it.

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**Title:** Travel Plans: New Business Opportunities for Suppliers of Information and Communications Technologies

**Authors:** DTLR

**Reference:** Energy Efficiency Best Practice Programme, General Information Report no. 80 [www.energy-efficiency.gov.uk/transport/](http://www.energy-efficiency.gov.uk/transport/), 2000

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** Written by Andy Lake of HOP Associates in collaboration with the Energy Efficiency Best Practice Programme, this is part of a second wave of guides to 'Travel Plans' (or Green Transport Plans) commissioned by the DTLR. The DTLR's aim is to encourage third parties – here ICT suppliers – to promote travel reduction through their marketing and client liaison activities.

The guide outlines the main applications that can have a travel reduction effect, and other (non-transport) business benefits. It contains numerous short case studies illustrating measured travel reductions achieved by businesses and public sector organisations through their use of ICT.

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**Title:** E-Commerce and Consequences for the Logistics Industry

**Authors:** Hultkrantz, O. & Lumsden, K.

**Reference:** ISSN 0283-4421, 2000

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**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** The aim of this study is to examine the impacts of e-commerce on logistics from 3 perspectives - the shipper; the transport/logistics provider; the environment

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**Title:** **Trucks Online: National Road Transport Scoping Study**

**Authors:** The National Office for the Information Economy (NOIE) (Australia).

**Reference:** [www.noie.gov.au/Projects/ecommerce/Sector/Transport/index.htm](http://www.noie.gov.au/Projects/ecommerce/Sector/Transport/index.htm), 1999

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This report was commissioned by NOIE, in 1999 to explore the use and potential of e-commerce within the road transport sector. The project was limited to an analysis of the Australian road freight transport industry. Data for the report were collected from structured interviews with a wide variety of organisations and industry figures, and a targeted telephone survey. A random sample of 250 road transport operators were chosen from transport directories for New South Wales, Victoria and Australia. Many case studies of use of ecommerce are included.

This report is an excellent overview of the impact/potential impact of information communications technology upon the freight industry, in terms of business-to-business ecommerce. The primary focus is on business processes, logistics management and the potential efficiency benefits for the haulage industry. It does not deal with impacts on traffic levels, but is a useful supporting study for this project.

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**Title:** **Preparing your Organisation for Transport in the Future**  
*The Benefits of Green Transport Plans*

**Authors:** DTLR

**Reference:** [www.local-transport.dtlr.gov.uk/travelplans/guide/index.htm](http://www.local-transport.dtlr.gov.uk/travelplans/guide/index.htm), 1999

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** Written by Adrian Taylor and Colin Black (Oscar Faber Ltd), Stephen Potter (Open University) and Tom Rye (Napier University) this is one of the earlier guides produced by the (then) DETR on the topic of Green Transport Plans. Amongst other benefits, the guide advocates use of ICT to reduce travel.

A 32-page booklet, it includes short sections on reducing travel through 'teleworking/telecommuting' and 'teleconferencing' (– a rather unusual distinction not followed by other authors). It includes a number of brief case studies, including a reference to ADAS Consulting (formerly a government department) that has 500 staff working from home who have on average reduced their work-related car use by 2,000 miles per year.

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**Title:** **Washington Metropolitan Telework Demonstration Project**

**Authors:** Harriet West, Telecommuting Manager, Metropolitan Washington Council of Governments

**Reference:** [www.mwcog.org/commuter/teleresult.html](http://www.mwcog.org/commuter/teleresult.html), 1999

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** This is the interim report of the project, summarising findings from the case study organisations.

**Title:** **Proceedings of the 1999 Telework Assembly, Aarhus**

**Authors:** Millard, J. (Ed.)

**Reference:** [www.eto.org.uk/twork/aarhus99/aarhusmain.pdf](http://www.eto.org.uk/twork/aarhus99/aarhusmain.pdf), 1999

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This is a collection of numerous papers from the annual European Telework Assembly. The papers cover a wide range of issues, and form useful background to the project. The most relevant paper, by Hopkinson et al, on *The Environmental Effects of Teleworking* is reviewed separately.

**Title:** **Teleworking Britain**

*A study into the adoption and acceptance of teleworking within British Business*

**Authors:** Mitel & MORI

**Reference:** Mitel Telecom Ltd; ISBN 0 9533837 0 9, 1998

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** The report is based on research conducted by MORI and commissioned by Mitel Telecom. It explores attitudes of both employers and employees to teleworking, inter alia taking in attitudes to commuting. It also explores extent of teleworking and barriers to its uptake, not least of which are lack of proper IT and telecommunications systems, and lack of corporate policies on telework.

**Title:** **Teleworking and Local Government**

*Assessing the costs and benefits*

**Authors:** Huws, U

**Reference:** LGMB - ISBN: 0 7488 9366, 1998

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** An important overview of the implications of telework for local government. The section on transport covers much the same ground as the more substantial work by the same author, *Teleworking – An Overview of the Research*.

**Title:** **Driven to Shop?**

*Role of Transportation in Future Home Shopping*

**Authors:** Gould J.

**Reference:** Transportation Research Record 1617, 149-156, 1998

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper has been superseded by Gould J. and Golob T. (1997) Shopping Without Travel or Travel Without Shopping? An Investigation of Electronic Home Shopping.

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Transport Reviews Vol. 17, No. 4, 355-376, despite the chronological order of the papers. It concerns very early electronic shopping, suggesting possible markets and research areas.

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**Title:** Experiences with Telecentres in Germany and Abroad - Top or Flop?

**Authors:** Korte, W.B

**Reference:** empirica GmbH (Bonn)[www.ework.fi/english/reports/report2.html](http://www.ework.fi/english/reports/report2.html), 1998

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This report on a Finnish telework site (and on other sites, too) is by one of the leading authorities in Europe on the development of telework. It looks at the phenomenon of telecentres, telecottages etc in Europe and the USA. Differences between countries are noted.

It sees telecentres as a valuable but marginal phenomenon, and reflects that few of them are commercially successful. Those that prosper benefit from public subsidies. Transport effects are not the focus of this short report.

The findings may be of significance in attempting to quantify the wider transport effects of use of telecentres, providing a brake on the more speculative extrapolations from individual case studies.

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**Title:** A Manager's Guide to Teleworking

**Authors:** Huws, U

**Reference:** Department for Employment and Skills, 1998

**Travel issues:** Commuting: No, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** This Guide, commissioned by the former Department of Employment, contains useful general advice on teleworking for people managing teleworkers. But it misses the opportunity to say anything substantial about work-related travel, which is often a key concern for managers.

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**Title:** Jam Today, Jam Tomorrow  
*Travel Substitution – What We Know and What We Don't*

**Authors:** Lake, A.S.

**Reference:** Flexible Working magazine March 1998[www.flexibility.co.uk/issues/TS\\_travsubsummary.htm](http://www.flexibility.co.uk/issues/TS_travsubsummary.htm), 1998

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** This article, originally published in Flexible Work magazine, summarises the state of research into travel substitution through telework. An updated version appears on the Flexibility website. It concludes that while research into the direct results of teleworking usually illustrates significant travel reduction effects, the 'jury is still out' on the wider effects.

The article is superceded by the current project.

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**Title:** **Telecommuting 2000**  
*The Future of Transport in the Information Age*

**Authors:** HOP Associates

**Reference:** [www.flexibility.co.uk/telecommuting2000](http://www.flexibility.co.uk/telecommuting2000), 1998

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** Sponsored by Symantec and Mitel – private sector companies in the IT and telecommunications sectors - the Telecommuting 2000 project aimed to provide an informed response to the 1998 Transport White Paper, which barely mentioned telework as a travel reduction option.

The report provides an overview of the travel reduction potential of telework, set against a detailed analysis of the business, personal, social and environmental costs of car use. It does not seek to provide any new data on the transport substitution issue.

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**Title:** **Modelling the Post-Industrial City**

**Authors:** Hall, Peter

**Reference:** Futures 29, no 4/5 pp311-322 1997, 1997

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper poses the question of how to adapt the urban and transportation models developed in the 1960s to the new kind of globalised city emerging in the Information Age.

The new kind of city is characterised as 'globalized', 'tertiarized and even quarternarized' (i.e. with its economy almost entirely dependent on advanced services), 'informationalized' and 'polycentric'. The author recommends developing models that recognise and measure information exchange.

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**Title:** **Telecommunications Technologies and Sustainable Development**  
*A guide for Local Authorities*

**Authors:** BT Environmental Issues Unit

**Reference:** [www.bt.com/World/environment/agenda21/ag21\\_sum.htm](http://www.bt.com/World/environment/agenda21/ag21_sum.htm), 1997

**Travel issues:** Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** BT commissioned UKCEED to examine the role of telecommunications and the 'information superhighway' can play in Local Agenda 21 initiatives. The report outlines the areas of ICT development that can impact on local authority functions, such as telework, tele-education, telerestructuring, etc. Transport impacts are only briefly mentioned, without quantification, in terms of telework being a way to reduce traffic, with warnings that more non-work trips and residential migration to suburban and rural areas might result.

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**Title:** **The Future of Telecommuting**

**Authors:** Handy, S.L., & Mokhtarian, P.L.

**Reference:** Futures 28(3), 1996, 227-240, 1996

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper assesses the future of telecommuting by outlining and evaluating important trends in a variety of factors and explores the need for new policies and further research on telecommuting. Other studies of a similar nature by these authors have detailed reviews in the database.

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**Title:** **Urban Transport, Information Technology and Sustainable Development**

**Authors:** Hoejer, M.

**Reference:** World Transport Policy and Practice 2/1,2 (1996) 46-51, 1996

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: Yes, Leisure: Yes

**Overview:** The article examines 4 IT/transport scenarios, where IT supports car pooling, dynamic route choicee, extended public transport, and a dual mode option.

So the focus is primarily on IT-supported physical transport. In the author's view, the necessary precondition for electronic communication to start to replace physical transport is for the cost of transport to rise, and for the cost of every individual trip to become visible.

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**Title:** **20 Seconds to Work - Home-based Telework**  
*Swedish experiences from a European perspective*

**Authors:** Forseback, L.

**Reference:** Teldok Report 101E; ISSN 0281-8574, 1995

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This remains one of the most informative and entertainingly-written works on the experience of teleworking. It contains numerous case studies of individuals who have taken up home-based telework, from a variety of backgrounds and in a range of occupations. It also contains ana anlysis of the uptake of telework and the motivating forces behind current trends.

Transport is not the focus of the book, although it is an issue for many of the case studies and in the analysis. There is an unusual approach to cost calculations, including relocation, that are of some relevance, perhaps, to this study.

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**Title:**           **Teleworking and Rural Development****Authors:**       Huws, U., Honey, S., & Morris, S**Reference:**      Rural Development Commission, Rural Research Report no 27. ISBN 1 869964 53 5, 1995**Travel issues:**   Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No**Overview:**       The aim of the research project leading to this report was to examine the extent, nature and future trends of teleworking in rural areas, and its implications for economic development in rural areas.

The report concludes that there is insufficient data to give reliable estimates of the extent of teleworking in rural areas. It does seek to give 'some impression of the geographical distribution of various forms of teleworking using various indicators'.

This is an example of a report using an interesting cocktail of data sources in combinations and for purposes that they were not intended. Though there are some conclusions about locations of teleworkers and speculation about telework and travel, it would be unwise to extrapolate or infer any transport effects from this source, or seek robust indicators for prevalence of teleworking. The recommendations for further research and for training for the rural workforce, however, have value.

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**Title:**           **Working at a Distance: UK Teleworking and its Implications****Authors:**       Parliamentary Office of Science and Technology (POST)**Reference:**      , 1995**Travel issues:**   Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No**Overview:**       The report is aimed at raising awareness amongst parliamentarians. It is based on research carried out by a team of researchers at the Centre for Urban and Regional Development Studies at Newcastle University, *Review of Telework in Britain: Implications for Public Policy* (which is reviewed in full).**Title:**           **Teleworking in Britain**  
*A report to the Employment Department***Authors:**       Huws, U.**Reference:**      Employment Department [now DFES] Research Series no 18, 1993**Travel issues:**   Commuting: No, In-business: No, Freight: No, Shopping: No, Leisure: No**Overview:**       An important and pioneering work on UK teleworking, contributing greatly to the understanding of the phenomenon. It does not, however, address transport issues to any significant degree.

**Title:** **Telecommuting and Travel: State of the Practice, State of the Art**

**Authors:** Mokhtarian, P.L.

**Reference:** Transportation 18(4), 1991, 319-342. , 1991

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** This paper provides an overview of the status of telecommuting in the United States, especially as it relates to changes in travel behaviour. Regarding the state of the practice, the paper discusses some refinements to the definition of telecommuting that have developed through increased operational experience. It reports several policy statements involving telecommuting, and explores the appeal of telecommuting as a public policy instrument. It highlights some trends in the implementation of home-based and work centre-based telecommuting, and suggests that visible public-sector involvement has been crucial to the increased activity in this area.

The study has been largely superceded by later reviews.

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**Title:** **Telecommuting and Urban Sprawl: Mitigator or Inciter?**

**Authors:** Nilles, J.M.

**Reference:** Transportation 18, 1991, 411-432, 1991

**Travel issues:** Commuting: Yes, In-business: No, Freight: No, Shopping: No, Leisure: No

**Overview:** The study is an early attempt to see if there is evidence that telecommuting promotes urban sprawl. Tentative evidence is cited from telecommuters who moved house during pilot programmes in California. For some, telecommuting was a possible contributory factor. However, the study concludes the overall traffic reduction effect of teleworking outweighs any sprawl effects.

It would be rash to conclude anything either way from the evidence, and the author outlines different scenarios for the spatial impacts of telecommuting.

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**Title:** **A Typology of Relationships between Telecommunications and Transportation**

**Authors:** Mokhtarian, P.L.

**Reference:** Transportation Research A 24(3), 1990, 231-242, 1990

**Travel issues:** Commuting: Yes, In-business: Yes, Freight: No, Shopping: No, Leisure: No

**Overview:** Seminal work by leading US researcher, outlining relationships between telecommunications and transport. The author suggests that all communication depend on one of 3 forms of transport: transport of people, or objects, or electrical impulses. Each mode can substitute for or stimulate the others, but the absolute amount of all forms of transport increases. Two empirical studies are included, one of telecommuting decreasing physical travel, the other of an atypical video-conferencing event which increased travel due to its popularity.

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### **7.3 Appendix 3 – List of non-transport studies useful for background**

<b>Year</b>	<b>Title</b>	<b>Authors</b>
2000	Computer Industry Almanac, 8th Edition	Computer Industry Almanac.
2001	Information Industry and Technology Update, 2001 and Beyond	IDC
2001	The Global Market Forecast for Internet Usage and Commerce: Based on Internet Commerce Market Model, Version 7.	IDC (see IDC website for details – but costs \$4500)
2000	ECATT: Benchmarking Telework and Ecommerce in Europe	EC, Empirica
periodical	Labour Force Survey – for telework questions in quarterly surveys	ONS
periodical	Internet Access	ONS

**7.4 Appendix 4 – List of continuing related projects**

<b>Year</b>	<b>Title</b>	<b>Contact</b>
2001	TRIP Project (Denmark)	Jeremy Millard, Danish Institute of Technology
2001	DEESD: Digital Europe: e-business and sustainable development	Mr Vidhya Alakson, Forum for the Future Heidi Seybert, EC
2001	SUSTEL: Sustainable Telework - Assessing and Optimising the Ecological and Social Benefits of Teleworking	Prof Peter James, The UK Centre for Economic and Environmental Development Heidi Seybert, EC
2001	The influence and effects of ICT on business travel	University of Delft and Dutch Ministry of Transport - Hock N. Lim
2000	CATPIE: Co-ordinated Advanced Telework Pilots In Europe	Kitty de Bruin, Telewerkforum, NL

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## 7.5 Appendix 5 – Sample full review

### Details of selected publication

#### Basic information on the publication:

<b>Brief title:</b>	E-business Impacts on the Transport System
<b>Descriptive sub-title:</b>	(series of working papers)
<b>Authors:</b>	Smith, N., Ferreira, L. & Mead, E.
<b>Publication medium:</b>	Project report
<b>Location of publication:</b>	
<b>Web reference if available:</b>	<a href="http://www.nts.gov.au/media.htm#ebusinesspapers">http://www.nts.gov.au/media.htm#ebusinesspapers</a>
<b>Year of publication:</b>	2001
<b>Is the information in the public domain?</b>	Yes

#### Further information:

<b>Type of study:</b>	None of these
<b>Type of research:</b>	Mixture of primary and secondary research

#### Publication addresses following issues

<b>- Travel to work:</b>	No
<b>- In-business travel:</b>	No
<b>- Freight distribution:</b>	Yes
<b>- Travel to shop:</b>	Yes
<b>- Travel for leisure:</b>	Yes

#### Summary of the publication:

**Short overview:** This is a series of 9 working papers on the subject of the impact of e-business on transport in Australia, prepared for the National Transport Secretariat of Australia

**Summary:** The reports highlight a range of issues relating to travel patterns and the impact of e-business transport. These include the impact of e-commerce on B2C – shopping trips, tourism and business travel, logistics – B2B and B2C impacts, online freight exchanges, etc. The reports also address a number of other issues relating to the impact of e-commerce usage. These encompass, environmental impacts – greenhouse gases, health, safety, socio-economic patterns, employment, urban sprawl impacts etc.

The 9 papers are as follows:

1. Introducing the Transport Impacts of E-business Project
2. E-business Trends
3. Transport Impacts and E-business
4. Insights from Stakeholders/Experts
5. Data and data source issues in assessing the transport impacts of E-business
6. Regional Impacts of E-business in Australia
7. Report Quantification of Key National Impacts and Trends
8. Report on Opportunities for Transport-related Productivity Gains
9. Report on Global E-business and Transport Related Opportunities and Threats

**Conclusions:**

Each report includes some conclusions. For an overview of the major research findings, Annex A of the subsequent Action Plan 'Meeting the E-Business Challenge to Transport - Draft National Action Plan for comment' (September 2001) provides a concise summary. Findings include:

- (B2C) Early 'ball park' calculations show that in 2005 ecommerce will generate only approx 1.1 million extra kms in shopping trips
- but e-business has the potential to create c50% increase in inter-city articulated truck trips (number of, not tonnage)
- e-business has the potential to to double 1999 total of Light Commercial Vehicle urban trips - though capacity will probably limit this to 50%
- the greater part of these increases will due to B2B rather than B2C
- E-business technology is changing the supply chain for numbers of goods and services - 'pull' rather than 'push'
- As rail is competitive for long-haul freight movements, and is likely to have a higher share of the increased freight movements
- e-business technologies are helping to make rail more competitive
- -e-business is also creating efficiencies in the maritime sector, but extensive use of EDI means that impact of newer Internet-based technologies is limited
- new technologies and systems are predicted to increase the amount of air travel - an extra 16% of inter-city trips.

**Review of the publication:****Reviewer's comments:**

This report covers a number of areas relating to the impact of e-business upon transport. The focus however is primarily on impacts for the transport industry - coverage of the issues is considerably thinner when looking at the travel behaviour of individuals.

There is a good and informed coverage of ICT issues, and a strong awareness of the types of technologies used for e-business. The input from experts in Working Paper 4 gives good insights into the potential application of the technologies.

The focus does though tend to be on systems for transport logistics and supply chain, rather than the wider business issues and implications, and this may skew the overall balance of the research to some extent. There appears to be a very thorough understanding of the transport and transport policy issues.

However, less attention is paid to the wider socio-economic and business contexts of both the impact of e-business and other driving forces behind changes in travel behaviour.

In terms of the methodology: the study aims to gather baseline information – through a variety of means: literature review, qualitative information from stakeholders/experts, data availability appraisal – and from that to estimate the impacts of e-business on the transport system, and develop an action plan for future monitoring and research activity.

As a broadbased process it has merits. In practice, it does rely somewhat heavily on a limited number of research reports. Some of the inputs have high levels of subjectivity, and there are subjective aspects to the linkages made between the different elements of the research. There are numerous occasions where causality is asserted, rather than demonstrated: e.g. that there will be an increase in air travel due to knowledge of increased opportunities via the Internet. The undemonstrated assumption here is that use of the Internet is the cause of the increase – rather than watching holiday programmes on TV, or higher living standards (etc). Similar assumptions are made in terms of e-shopping behaviour. However, the research is exploratory, and the researchers are at pains to say that the figures arrived at are 'ball-park', as a way of starting the debate and identifying areas for future monitoring and research.

The results are to a large extent the fruit of secondary activities.

The figures for trip generation are based on projected uptake of B2B and B2C activities, and the basis for this seems to be primarily a 1999 report from IDC with projections up to 2003. Few analysts would now wish to rely on those figures.

The other problem is that the report is very inwardly focused on the transport sector. So high weight is given to the streamlining of logistic and other processes in the transport sector and the projected potential of that to create the capacity in companies for making more trips.

But no weighting is given to the capacity for streamlining processes in business as a whole, and whether that has any potential for trip reduction or generation.

Recommendations are in the areas of : raising awareness, improved data gathering, forming partnerships between government and the transport industry, reviewing transport policy.

While specific actions are proposed in each of these areas, further research, monitoring and improved data collection are the priorities as they underpin the success of the other activities.

Allowing for the reservations mentioned above, there is scope for adopting some of the approach in the Australian study in the UK context.

#### Reviewer's scores:

- ICT understanding:	Above average
- Transport understanding:	High
- Socio-economic understanding:	Average
- Coherence of methodology:	Above average
- Transferability of	Average

**methodology:**

**- Accuracy of results:** Average

**- Value of recommendations:** Above average

**Contacts:**

**Contact for publication:** Hal Morris

**Name of reviewer:** Andy Lake

**Review date:** 25-9-2001