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**Gathering empirical evidence on the impacts of ICTs:  
using 'accessibility diaries' to investigate the changing nature of  
Internet use, personal travel and participation in activities**

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**Abstract**

This paper begins to consider emerging results from an empirical study into the effects of Internet use upon personal travel and individual access to/participation in activities. Outlining the conceptual links between Internet use, accessibility and social exclusion, the paper turns to present an innovative methodology, the accessibility diary. The accessibility diary, derived from an assessment of existing diary methods, seeks to overcome the limitations of activity, communications, time use and travel diaries as survey tools in this area of research by asking participants to record not only their travel, but all online and offline primary and secondary activities. The diary will be repeated up to four times, at six-month intervals, providing longitudinal data from a panel of c. 100 participants. This paper considers data from the first wave, undertaken in March 2004.

Please note: this paper presents work in progress. Further to database preparation, data cleaning and pre-processing, the analysis is ongoing but not yet complete. Accordingly, the paper presents a full account of the methodology and methodological advances stemming from the research, alongside an overview of the key issues which the authors expect to have addressed in a later version following the Utrecht Meeting. The authors anticipate being able to present some of their empirical results at the time of the Meeting.

## Introduction

Whilst the research field of telecommunications and travel is well established, the dissemination literature continues to be accompanied with acknowledgements that empirical evidence in order to understand the relationships between information and communications technologies (ICTs) and travel is in short supply. The inadequacy of existing empirical evidence is further exacerbated by the changing nature of ICTs and their use in the 'information society'. The (mainstream) Internet is still in its infancy – indeed, the world wide web is barely a decade old – and use of the Internet in the UK has only recently reached the majority. Much of the existing research into ICT/travel interactions predates the arrival of the popular Internet, yet in its first few years of mainstream use, the Internet has provided a wealth and diversity of opportunities and services. Thus, it can be suggested that the nature, extent and consequences of its popular use, by the majority, are currently poorly understood.

Research to date has also tended to focus on a need to gain empirical understanding of the *two-way* interactions between ICT use and travel. Both in terms of political salience and the pursuit of better, more comprehensive understandings, there may be merit in seeking to address the *three-way* interactions between ICT use, travel and social participation. People travel in order to access the opportunities, services, social networks and other goods that are necessary for them to participate in the societies in which they live. This access underpins personal welfare and a deficit of access can give rise to (aspects of) social exclusion.

In the UK, key policy documents simultaneously acknowledge the potential significance of social and technological change for personal travel and recognise the lack of empirical evidence and understanding (DETR, 2000a). Meanwhile, policymakers continue to offer statements of policy that appear to take no account of ICTs or the Internet, in particular, as a means of access (DfT, 2004).

Mokhtarian (2003) notes that the 'ultimate question' is 'not the existence of, say, substitution effects (which certainly do exist), but the net outcome of all the effects we have identified here (i.e. the overall change in demand for each mode)'. This important question is one that still eludes a definitive answer and it concurs with the common policy interest in foreseeing aggregate change over time. However, it is certainly not the *only* question. It is important to acknowledge that no *net* aggregate effect is not the same as no effect. Zero net effect in terms of the amount of travel (by a given mode) can arise despite the fact that some individuals travel more and some, less. While this might imply no change in terms of transport system management (balancing supply and demand), it could represent significant changes in the spatio-temporal distribution of travel demand and also in the social benefits accrued to the individual and society from behavioural change.

In order to address the issues outlined above, the authors propose the need for a longitudinal panel study, which focuses on Internet use and personal travel and which seeks to account for their influence upon, and how they are influenced by, individuals' social participation. This paper concerns such a study in the UK.

The paper begins by establishing the conceptual framework, which underpins and shapes the study (based on preceding work by the authors). It then introduces the methodology for the study, namely a newly developed 'accessibility diary'. In terms of the aim of this study, the characteristics of the accessibility diary and how they are distinct from those of preceding diary studies are discussed in some depth. The paper then provides a summary of the characteristics of the c.100 individuals who have participated in the first wave of the longitudinal panel study. Finally, consideration is given to the key issues and associated empirical evidence that are emergent from the study. This Meeting usefully coincides with the time at which analysis of first wave data is taking place, which in turn will more fully inform this important final section of the paper. Accordingly, the paper should be viewed as a

work in progress. Following insights and feedback from the Meeting and further analysis, a revised final version of the paper will be submitted later in 2004.

### **Conceptual framework: accessibility, physical mobility, social exclusion and the Internet**

Individuals and the opportunities, services, social networks and other goods<sup>1</sup> that they 'need' (both individually and culturally defined) to reach in order to participate fully in society are separated by physical distance, to varying degrees. Whilst not the only determinant<sup>2</sup>, the physical location of activities and the time/space barriers that separate them greatly informs the extent to which individuals are able to access and, in turn, the extent to which they are able to feel included in, the practices common in the society in which they live. Thus, in this geo-spatial definition of accessibility, the accessibility of goods to individuals (and groups) is a function of the ease with which this physical space can be traversed. Participation is therefore determined by the extent to which the individual is capable of moving between spaces, enabling the individual to be in the right place, at the right time, in order that they can participate in their chosen, or necessary, activity.

Thus, physical mobility is an essential factor in enabling the individual to overcome this 'capability constraint', providing access to participation (Hagerstrand, 1970). Increasing the speed of physical mobility in turn increases the spatial range of accessible activities (or eases the temporal constraints associated with activity participation). Motorised mobility has become a key enabling factor in accessibility, increasing the space-time prism within which the individual can operate and thus the goods that are within the individual's accessibility zone. It is in this sense that Couclelis (2000) describes accessibility as 'the geographic definition of opportunity': a geographic expression of the individual's ability to participate, culturally, economically, politically and socially, within the society in which they live.

For those with access to motorised mobility, these accessibility technologies have increased the number and range of goods available. The ability to travel faster has brought with it the ability to travel further and, from this, a socio-cultural expectation of travel, which is in turn played out in the built environment, shaping service provision and informing the construction of an environment that is built around the assumption of high mobility. In short, in enabling greater accessibility in time and space, the prevalence of motorised mobility has resulted in both the dispersion of goods and in an increase in an expectation of accessibility. As a result, those without access to motorised mobility experience reduced accessibility. In consequence, mobility-related social exclusion can occur.

Social exclusion is a concept that has increasingly gained credence in Western societies, adopted fully by the UK government and integrated into policy making since the late 1990s. A short-hand term for a complex process of multiple disadvantage, the concept highlights the material and non-material causes and consequences of deprivation that combine to produce a state in which the individual or group concerned experiences reduced life chances, choices and citizenship. Producing a framework of understanding to operationalise the concept,

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<sup>1</sup> In this paper, 'goods' is taken to refer not merely to consumables but also to community, economic, political and social goods, including opportunities, services and social networks.

<sup>2</sup> It is not the intention of this paper to suggest that spatial constraints are the sole determinants of accessibility. Indeed, the definition of social exclusion used in this research (discussed below) recognises the multi-dimensional nature of disadvantage and, within this, the multi-dimensional nature of mobility-related social exclusion. Rather, the spatial definition of accessibility underlies this aspect of this research. For a critique of the spatial definition of accessibility, premised upon its failure to consider other constraints on accessibility, including informational, social and cultural constraints, see initially Hanson, 2000. Hagerstrand (1970) similarly emphasises additional accessibility determinants: coupling (which can be broadly interpreted as scheduling constraints and is closely linked in to this research) and authority.

Kenyon et al (2002) highlight nine dimensions of social exclusion, of which mobility features prominently. This mobility-related dimension, which could perhaps more appropriately be termed the *accessibility-related* dimension of exclusion, is seen to both enforce and reinforce exclusion in many of the other dimensions. Table 1, adapted from Kenyon (2003), illustrates the ways in which mobility, or accessibility, can influence exclusion in each of the dimensions.

Dimension of exclusion	Influence of lack of mobility and resultant reduced accessibility: some examples
Economic	Unemployment – inability to take a job because of lack of adequate access to interview and to place of employment. For example, 38% of jobseekers say that lack of transport is a barrier to employment; 12% say that lack of transport has stopped them from attending interview.
Living space	Geographical isolation and low level of service provision locally – lack of mobility reinforcing isolation and low accessibility of key services. For example, it is estimated that, every year, 1.4m people miss out on medical help because of transport difficulties.
Mobility	The cost, routing, timing, accessibility of public transport and the cost and accessibility of private transport acting as inhibitors to the accessibility of opportunities, services, social networks and other goods.
Personal	Factors including ethnicity, culture, gender. Ignorance and discrimination linked to lack of integration, itself a result of poor intra-community accessibility.
Personal political	Personal disempowerment – linked to low levels of knowledge, often as a result of the poor accessibility of information and support networks.
Organised political	Low participation – linked to inaccessibility of participation opportunities, e.g. travel to meetings, which are often in the evenings in centralised locations.
Social networks	Loneliness and isolation – lack of adequate access to family and friends, or to social opportunities to meet new friends. For example, 18% of non-car owners find it difficult to see family and friends because of transport problems; as do 8% of those with access to a car.
Societal	Poor educational opportunities – inaccessibility of learning venues. A problem for young and old potential learners. Statistics suggest that 6% of students have missed college because they cannot afford the transport; 6% 16-24 year olds have rejected FE because of transport costs.
Temporal	Time poverty – the time taken to travel between activity spaces reduces time for participation in activities, a problem for private and public transport users alike.

Table 1: Accessibility, mobility and social exclusion<sup>3</sup>

Thus, lack of mobility and the resultant lack of accessibility in societies that are structured, both physically and socio-culturally, around motorised mobility, can both cause, reinforce and arise as a consequence of social exclusion. The dominant response to concerns regarding mobility-related exclusion, both in the academic literature and for government, has been to suggest the provision of an increase in mobility to facilitate an increase in accessibility, for those experiencing an accessibility deficit (for example, Church, Frost and Sullivan, 2000; DETR, 2000b; SEU, 2003). In this sense, transport is conceptualised as a tool in the fight against social exclusion, enabling access to opportunities, services, social networks and other goods.

However, the authors believe that an increase in mobility is problematic, given the negative community, health and social effects of mobility and its role in increasing deficits in, or inequitable distribution of, accessibility within society. Alongside measures to reduce the

<sup>3</sup> All statistics are taken from SEU (2003) and are for GB or the UK. Statistics and examples included are indicative, not exhaustive.

accessibility burden<sup>4</sup>, through land use planning initiatives to integrate individuals and the goods that they seek to access, this study seeks to examine the possible role of virtual mobility<sup>5</sup>, or virtual accessibility, in the alleviation of mobility-related exclusion. Such a role has previously been hypothesised by authors including Burrows et al (2000) with relation to social support, Carter and Grieco (Nd) with relation to healthcare, Hampton and Wellman (2003) with regard to community and by the present authors, following examination of the use of Internet facilities by socially excluded groups (Kenyon et al, 2003).

However, for virtual mobility to reduce mobility-related exclusion, it must provide similar (if not the same) accessibility functions and satisfactions as physical mobility. In the least, it must fill the accessibility gaps that a lack of physical mobility leaves. It must also be proven that virtual mobility does not have any negative mobility or social effects that may worsen mobility-related exclusion, or social exclusion as a whole. The likelihood of success of virtual mobility in relation to the above social and transport caveats has been questioned by authors including Black (2001), Graham (2002), Kraut (1998), Mokhtarian (2003) and Mokhtarian and Salomon (2002).

Whilst the impacts of virtual mobility upon personal mobility and social exclusion are uncertain, the effects may be profound, warranting attention in both transport and social policy. The development of an understanding of the possible accessibility and thus mobility and social effects of Internet use is, therefore, a fundamental objective of this research. Whilst various studies into the social or transport effects of Internet use (or ICTs more broadly) and, more recently, the social effects of mobility, have emerged, the authors are unaware of existing research which combines the three. This research is thus unique in uniting these three aspects in a single study, to examine the 'triangle of influence' between Internet use, personal travel and social exclusion and the impacts of these interactions upon accessibility, as depicted in Figure 1.

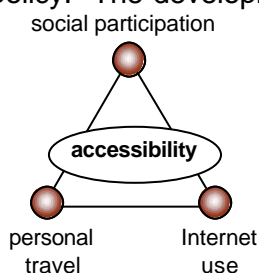


Fig. 1. Triangle of influence

## Methodology – the 'accessibility diary'

Whilst diaries have been used in research for many years, a cross-disciplinary review of existing diaries revealed that no single approach allowed participants to record their activities to the level of detail necessary to fully assess the accessibility, mobility and social impacts of virtual mobility. This part of the paper provides a brief overview of four diary traditions, before putting forward the data needs for this study and presenting the 'accessibility diary' developed to address those needs.

*Travel diaries*, used initially to collect data about trips to feed models which aim to predict and provide for traffic flows, collect information about the trips that people make – typically, the origin and destination of trips (to varying degrees of accuracy); departure and arrival times; mode(s) used; trip purpose and whether or not the traveller was accompanied. Such diaries are generally tabularised, constraining the participant to provide a chronological sequence of travel 'events' (for a full review of travel diaries, see for example Arentze et al, 2001; Axhausen, 1995; Butcher and Eldridge, 2003).

In contrast to travel diaries, *activity diaries* aim to collect information about the contextual factors that are suggested to be important in determining demand for travel, with reference to

<sup>4</sup> 'Accessibility burden' refers to both the distance between activities and the increasing number of activities in which an individual must participate in order to participate, each attributable to increased popular car ownership.

<sup>5</sup> 'A shorthand term for the process of accessing activities that traditionally require physical mobility, but which can now be undertaken without recourse to physical travel by the individual undertaking the activity' (Kenyon et al, 2002).

its place in every day life. Following activity-based theories of traveller behaviour, such instruments, pioneered by Jones et al (1983) and discussed by authors including Behrens (2003) and Harvey (2003), collect information not only on the trips undertaken during the day, but also on the activities in which the individual (or household) participated.

*Time use* diaries have contributed much to the design of many activity diaries, in both their conceptualisation of travel as a time-using activity of its own (although activity diaries tend to continue to treat travel as *primus inter pares*) and the integration of trip 'activities' into the main diary design. However, they have tended to record only one aspect of travel, for example travel purpose in a very generalised sense, without mode or interchange, a level of detail that is insufficient for those attempting to fully understand traveller behaviour (see for example Gershuny, 2000, 2002; also the excellent database of time use studies via <http://www.iser.essex.ac.uk/ulsc/projects/ldr4ss/index.php>). Such diaries have tended to be more qualitative in content and less constrained, or directive, than travel and activity diaries.

Finally, *communications diaries* aim to record communications activities, to varying levels of detail, including the time, mode, participation and direction of communications activities (for example, Anderson et al, 1999; Mokhtarian and Meenakshisundaram, 1999; Ohmori et al, 2004).

In addition to the above inter-disciplinary variation as a result of different research foci, the level of detail about activities and trips also varies *within* each diary tradition. Variation is evident not only in information recorded but also in medium – for example, paper-based or electronic; the degree of self-determination permitted; the degree of interviewer involvement; and survey duration. Despite some overlap in content there are no examples, to the authors' knowledge, which combine travel, activity participation, time-use and communications within a single survey instrument (whilst Ohmori et al 2004 collect activities, communications and travel data, the study uses three separate diaries to do so).

Although each methodology produces data that meet the research focus of its intended study, analysis of existing diaries revealed the lack of a single, comprehensive method that could confidently be used to gather the data necessary for this study into the accessibility, participation and personal travel impacts of Internet use. This study has a need for a survey instrument which can record:

- all online and offline activities, at a level of detail that distinguishes specific activities within high-level activity categories;
- mode of travel;
- activity sequencing and duration;
- activity location;
- sociability of activities; and
- multitasking.

The 'accessibility diary' has been developed to record these data. The diary used in the first wave of this research is presented in Figure 2. The activity categories used in this research – the key to the simplicity of the survey instrument for participants, yet the richness of the data gathered – are given in Figure 3. Each aspect of the diary is discussed briefly, below (for full discussion of the accessibility diary and activity codes, the reader is referred to Kenyon, 2004a).

Day(s)... Monday .....

What did you do? <i>Please write code for one main activity</i>	Start time	End time	Where did you do it? <i>E.g. at home; at office; between home and work...</i>	Did anyone else do this with you? <i>Yes / No</i>	Was anyone else around at the time? <i>Yes / No</i>	What else were you doing? <i>Please enter code and duration for up to three additional activities</i>					
						Code	Dur.	Code	Dur.	Code	Dur.
H1	:	07:00	At home	Yes	Yes						
H2	07:00	07:30	" "	No	Yes	E8	30				
H3	07:30	07:45	" "	No	Yes	E8	15				
T9	07:45	08:00	Home to bus stop	No	No						
T3	08:00	08:15	Bus stop to train station	No	Yes						
T5	08:15	08:40	Station to station	No	Yes	F1	20				

Figure 2: The accessibility diary.

Communicating:		Entertainment / recreation		Formal activities		Household and personal	
C1	Face to face	E1	Resting, relaxing	F1	Paid work	H1	Sleeping
C2	By telephone (landline)	E2	Reading	F2	Education	H2	Personal care
C3	By mobile telephone	E3	Do hobbies	F2I	Education – Internet	H3	Eating, drinking, inc. preparation
C4	By text, or video messaging	E4	Play sports	F3	Voluntary work	H4	Housework, household maintenance
C5	By letter	E5	Cinema, theatre, watch sport, etc.	F3I	Voluntary work – Internet	H5	Childcare
C6	By fax	E6	Social (pub, club, bingo...)	F4	Religious activity	H6	Other caring activities
C7	By email	E7	Watching TV, video, DVD	F4I	Religious activity – Internet	H7	Running errands (e.g. posting a letter)
C8	In chat room	E8	Listening to music, radio	F5	Campaigns, civic	H8	Escort (includes school run)
		E9	Travelling for pleasure	F5I	Campaigns, civic – Internet	H9	Banking, financial
		E10	Surfing (no specific purpose)			H9I	Banking, financial – Internet
		E11	Playing computer games			H10	Medical (includes GP, hospital)
C0	Other communicating	E0	Other entertainment / recreation	F0	Other formal activities	H0	Other household and personal
C0I	Other communicating – Internet	E0I	Other entertainment / recreation – Internet	F0I	Other formal activities – Internet		
Information search		Shopping for:		Travel		Other / Personal	
I1	Trivia	S1	Groceries (main)	T1	Driving the car	O1	Other activities
I1I	Trivia – Internet	S1I	Groceries (main) – Internet	T2	Travelling in car as passenger	O1I	Other activities – Internet
I2	Window shopping	S2	Groceries (top up)	T3	Travelling on bus		
I2I	Window shopping – Internet	S2I	Groceries (top up) – Internet	T4	Travelling by coach	O2	Personal activities
I3	Journey information	S3	Clothing	T5	Travelling on train	O2I	Personal activities – Internet
I3I	Journey information – Internet	S3I	Clothing – Internet	T6	Riding motorcycle or similar		
I4	Employment information	S4	Music	T7	Travelling in taxi		
I4I	Employment – Internet	S4I	Music – Internet	T8	Riding bicycle		
I5	Hobbies	S5	Journeys (not holidays)	T9	Walking		
I5I	Hobbies – Internet	S5I	Journeys (not holidays) – Internet	T10	Travelling on an aeroplane		
I6	Medical (inc. NHS Direct)						
I6I	Medical – Internet						
I7	News (includes TV, newspaper)						
I7I	News – Internet						
I0	Other information search	S0	Other shopping	T0	Other travel		
I0I	Other information search – Internet	S0I	Other shopping – Internet				

Figure 3: Activity codes.

### Variable 1. What did you do?

The accessibility diary takes the somewhat unusual step of asking participants to record their activity first, following the natural inclination to recall and structure ones day by activity, rather than clock time. This assumption, in line with the conceptual framework, was verified during pre-testing and in post-diary focus groups.

The activity is recorded using one of a number of activity codes (displayed for the participants' convenience above each page of the diary). Activity codes are used to increase accuracy, clarity and ease of response, ensuring that participants record activities to an

appropriate level of detail. Derived from both the time use/activity diaries literature (including Barrett et al, 2002; Gershuny, 2000; Jones, 1983; Keuleers et al, 2002) and from lists of activities undertaken during a week in the life of the research staff, the activities are grouped firstly into 89 codes, then into eight categories. The activity codes differ significantly from those used in existing diaries and closely reflect the aims of this research. Activities with low perceived importance are grouped into overarching codes – for example, all sports are within one code; similarly, all personal care. However, activities that are more central to the study, because of their potential online/offline substitutability or their influence upon other activities are coded in more detail. All communications, online activities and travel are thus coded separately.

*Variables 2 and 3. Start and end times.*

The start and end times of each activity are then recorded, to the nearest five minutes, providing information on activity duration and scheduling.

*Variable 4. Where did you do it?*

Activity location, recorded in variable 4, is intended to allow some assessment of the influence of virtual mobility upon the spatial spread of activities and the influence of space upon accessibility. The accessibility diary does not ask participants to record the precise location of activities, merely to indicate whether the activity was undertaken at home, work, whilst travelling, or at another location.

*Variables 5 and 6. Did anyone do this with you? / Was anyone around at the time?*

The sociability of activities is often cited as a barrier to the substitution of activities, by individuals and academics alike. Variables 5 and 6 ask participants to record who was involved in activities, alongside the presence of others at the time of the activity, to allow both an appreciation of the role of social networks in activity participation and of virtual mobility in providing access to social networks.

*Variables 7-12. What else were you doing?*

Finally, the accessibility diary provides space for participants to record the nature and duration of up to three secondary activities, reflecting an assumption that people often do more than one thing at once. It is intended that this should enable insights into the influence of multi-tasking on time use and scheduling of activities.

In addition to collecting the information that is judged to be *useful* to this research, the survey instrument faced the additional challenge of being immediately *usable* by participants. A number of factors, including the length of the survey (7 days), the longitudinal nature of the study (3-4 waves, over 1-2 years) and the volume of data to be collected, combined with the fact that the diary was to be self-completed by participants with a wide range of abilities (given that the subject of enquiry is social exclusion), ensured that usability must be a key aim. Whilst the emphasis upon usability reduces the volume of data that can be collected, necessarily leading to compromises, building usability into the survey instrument naturally reinforces its utility (usefulness), improving data quality and reducing participant attrition. As such, the diary was designed to:

- take no more than 15-20 minutes per day to complete;
- be intuitive to complete, following natural thought processes and working in the participants' natural language;
- be easily learnable, following one-to-one tuition during an inception meeting; and
- prompt the user to record all of the information needed, at every stage.

Initial analysis suggests that this emphasis upon usability has been beneficial. In the first wave, 92 diaries were distributed; 90 were accepted, with 2 participants falling ill and declining to participate in the study. 87 diaries were returned. There were remarkably few errors in each diary and just one diary required substantial editing such that it was excluded



from the primary analysis. Of these 87, 86 accepted the diary in the second wave<sup>6</sup>. Thus, the attrition rate between waves 1 and 2 was just 1%, caused by the death of one participant. Focus group-based research and post-diary questionnaires assessing the usability of the accessibility diary (reported in full in Kenyon, 2004b) further endorse its usability. This paper turns now to consider the utility of the data in meeting research aims.

## Sample composition

Following a one-year feasibility study, based upon qualitative research (reported in Kenyon et al, 2002, 2003) this research hypothesises the importance of the following factors in determining spatial accessibility, access to physical and virtual mobility, thus also activity participation, social participation and personal travel:

- income – seen to influence activity participation, Internet access/use and mode availability/use;
- Internet access and experience – hypothesised to influence confidence, exposure and thus participation in different Internet activities. All participants have Internet access at home;
- mode use – reflecting the difference in mobility patterns and, thus, activity patterns, because of the influence of mode use upon time-space activity prisms, between users of different modes, particularly car users and public transport users; and
- residential location – reflecting the differences in the physical availability of opportunities, services, social networks and other goods, according to the degree to which a settlement is rural/urban.

This study aimed to recruit c.100 participants, representing the range of variables given above. Six locations in the south west of England were chosen on the basis of population size, transport profile, services profile and proximity to other settlements. The study used non-probability sampling methods, also known as choice sampling, or purposive sampling. It was not the aim to gain a nationally representative sample of participants, for it was judged that the pursuit of representativeness in the sample was not the most appropriate way in which to make theoretical and analytical advances in relation to this research (Behrens, 2003; Mason, 1996). Rather, the study aimed to gain a sample representing the four factors deemed key to the research area, allowing study of these factors alongside a variety of key demographic data. In this sense, the sample was designed to be 'fit for purpose' (May, 2001). Participants were selected according to their degree of fit with criteria based upon the factors above, recruited using a variety of techniques including snowballing, the print media and with the assistance from an external public body.

Data on the above were collected using an interviewer-administered questionnaire during an inception meeting with each participant. A range of questions were used to determine travel mode use and Internet experience. Information about additional variables, which are seen to influence activity patterns, Internet access and mode use, including household structure, age and gender, was also collected at this stage (for full discussion of the sample strategy, including national statistics regarding each of the above variables, the reader is referred to Kenyon, 2004c).

Sample analysis highlights under-representation of lower income deciles and concentration of participants in the middle income deciles, vis-à-vis the national (GB) population. However, sample distribution across income deciles follows a similar pattern to that of Internet access by income decile nationally. Measures of Internet experience by the year that the participant first went online and the year that they became connected at home show a sample becoming

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<sup>6</sup> The second wave was conducted in September 2004 and at the time of writing, data entry is in progress.

'Internet ready' largely in the mid to late 1990s. The majority of the sample (68%) first used the Internet between 1994 and 1999 (90% from 1994 onwards); and the majority (52%) going online at home between 2000-2004. This pattern is repeated in national statistics, although only half of all GB households are online (mid-2004 statistics). Table 2 indicates participants' use of the Internet for various activities, indicating a mix of 'virtual mobility readiness' amongst the sample.

Activity	Yes - past week (%)	Yes – past 3 months (%)	No – not in past 3 months (%)
Personal banking, other personal financial activities	45	64	36
Communicating with family or friends by email	92	97	3
Communicating with family or friends in chat rooms, or instant messaging	23	30	70
Communicating with people that you don't know, e.g. email, chat rooms (not for work)	25	35	66
Education, for a qualification or course	15	31	69
Reading the news, or other information search (not for education)	54	85	15
Entertainment (e.g. games, surfing, reading)	40	64	36
Grocery shopping – main shop	7	24	76
Grocery shopping – top-up shopping	1	3	97
Other shopping e.g. clothes, music, travel	33	79	21
Paid work at work	30	35	66
Paid work in your home	30	35	66
Political activity or campaigning	9	20	81

Table 1. Internet experience: participants' use of the Internet

The sample contains a high number of car owners and car users, which is perhaps to be expected given the income profile. However, when asked about travel mode use, in terms of both frequency of use of a variety of modes and of mode of access to a range of key services, the majority of participants indicated a high degree of multimodality. This is shown in Table 3. With regard to residential relocation, sample participants are drawn from six locations decreasing in rurality from a small hamlet with a population of 500 to the inner suburbs of Bristol, a city with a population nearing 0.4 million.

Participants represent a broad range of ages, from 17 to 84, with the majority of participants falling within the 25-64 age range. The sample is heavily biased towards those with good educational qualifications – more than twice the national average hold higher level qualifications and the number in the sample with no qualifications is just 10% of the national (GB) average, although a similar pattern is reflected in the national Internet user profile. The majority (87%) live in a household with other adults; and a third live in a household with children. Almost 10% of the sample report a disability, the majority of which are described as mobility limiting. All participants in the sample are white.

	No. inc.	Car %	Car Pass. %	Bike %	Bus %	Train %	Walk %
Work	63	75	8	10	19	10	27
Grocery shopping: main shop	73	86	12	0	4	0	12
Grocery shopping: top up shop	82	51	6	7	6	0	60
Other shopping	85	73	12	60	21	60	28
Family and friends less than 1 mile away	75	29	11	11	5	0	75
Family and friends 1 – 5 miles away	83	84	18	11	11	1	12
Family and friends more than 5 miles away	86	86	24	1	4	19	0
Place of education for children	21	71	0	5	5	5	57
Place of education for you	20	65	0	5	20	5	20
Cash point	82	51	7	4	6	1	61
Banking – not just cash point	71	61	9	7	6	3	49
Doctor's surgery	85	61	8	12	6	0	42

Table 2. Travel modes used to access key activities<sup>7</sup>

## Emerging results and discussion of the data set

The paper now presents and discusses issues that will be addressed more fully following more detailed analysis, both in the presentation at the Utrecht Meeting and in a revised version of the paper.

The accessibility diary has the potential to provide a complex data set, embracing 89 named online and offline activities, alongside information about activity duration, multitasking, scheduling and the sociability of activities. The impact of individual characteristics upon behaviour will allow cross-comparison within waves (intra-diary analysis); and the longitudinal element will allow comparison between waves (inter-diary analysis).

### *Methodological lessons*

Initial analysis has focused upon data validation and upon the validation of the methodology, through an examination of the number and duration of activities, using top-level activity categories. Data were examined to assess the change in recording across the week and, as shown in Table 4, participants recorded fewer activities as the week progressed. Whilst this may be explained by natural variations in activity patterns, the possibility of reduced reporting due to participant fatigue cannot be ruled out.

<sup>7</sup> Percentages add up to more than 100 because participants could give more than one answer.

	Total primary activities	Total secondary activities
Monday	19	14
Tuesday	17	14
Wednesday	18	14
Thursday	18	13
Friday	17	12
Saturday	17	12
Sunday	16	10

Table 4. Average number of activities, per day

Analysis has revealed large variations in the number of both primary and secondary activities recorded by each participant. For example, the average number of primary activities per person per week is 122. However, the minimum number of primary activities recorded is 44, the maximum, 251, giving a standard deviation from the mean of 33.5. Variability is similarly shown in activities per day: mean, 17; minimum 4; maximum 50. For secondary activities, the variability is even more marked. Per week, the mean number of secondary activities is 88, yet the minimum 12 and the maximum 215, giving a SD of 46.5. Likewise, examination of how participants spend their time, using recorded durations and aggregating activities into categories, also highlights wide variations, as shown in Table 5.

Activity category	N (participants)	Minimum (minutes)	Maximum (minutes)	Mean (minutes)	Std. Deviation
Communicating	<b>86</b>	<b>0</b>	<b>1185</b>	<b>265 (4.4)</b>	<b>266</b>
	<i>86</i>	<i>0</i>	<i>8060</i>	<i>1637 (27.3)</i>	<i>1530</i>
Entertainment / recreation	<b>86</b>	<b>75</b>	<b>7110</b>	<b>1820 (30.3)</b>	<b>864</b>
	<i>86</i>	<i>105</i>	<i>5155</i>	<i>1684 (28.1)</i>	<i>1190</i>
Formal activities	<b>86</b>	<b>0</b>	<b>4403</b>	<b>1864 (31.1)</b>	<b>960</b>
	<i>86</i>	<i>0</i>	<i>2160</i>	<i>107 (1.8)</i>	<i>276</i>
Household and personal	<b>86</b>	<b>2790</b>	<b>7585</b>	<b>5102 (85)</b>	<b>865</b>
	<i>86</i>	<i>0</i>	<i>4495</i>	<i>857 (14.3)</i>	<i>948</i>
Information search	<b>86</b>	<b>0</b>	<b>740</b>	<b>113 (1.9)</b>	<b>147</b>
	<i>86</i>	<i>0</i>	<i>775</i>	<i>98 (1.6)</i>	<i>140</i>
Shopping	<b>86</b>	<b>0</b>	<b>425</b>	<b>140 (2.3)</b>	<b>104</b>
	<i>86</i>	<i>0</i>	<i>2270</i>	<i>81 (1.4)</i>	<i>251</i>
Travel	<b>86</b>	<b>20</b>	<b>1605</b>	<b>642 (10.7)</b>	<b>367</b>
	<i>86</i>	<i>0</i>	<i>5115</i>	<i>164</i>	<i>575</i>

Table 5. Duration of primary activities, in minutes, per person per week<sup>8</sup>

Whilst it may not be unusual to find variability in terms of entertainment/recreation activities, where variability could be explained by personal preference, formal activities (a category that includes paid work), or traditionally gendered activity categories, for example, shopping or household/personal activities, it is more difficult to explain such differences in

<sup>8</sup> Primary activities are shown in bold; secondary activities in italics. The duration is shown in hours alongside the mean minutes, in brackets.

communications activities. The variability in recorded secondary activities, also shown in Table 5, raises similar concerns.

Analysis has yet to disaggregate the above findings by person-type variables and thereby determine the likelihood of whether or not such variability is attributable to genuine differences in behaviour, or alternatively to differences in diary completion strategies. Such insights are likely to be significant in assessing the utility both of the methodological approach and of the data. If diary completion is ambiguous (in terms of a consistent approach to completion across participants) then the opportunity to explore intra-wave variability (between participants) may be limited. A similar concern relates to any examination of inter-wave changes (if individuals exhibit inconsistency of approach to diary completion between waves). Indeed, these concerns may not be limited to this study, but may raise questions regarding the ability of all self-completion survey tools to account for differences in reporting strategies when assessing behaviour. This is highlighted by focus group-based research into the usability of the accessibility diary. When questioned about their completion strategies, considerable variation emerged, despite one-to-one tuition and the provision of instructions that had been piloted to check their clarity (Kenyon, 2004b).

Given the above observations regarding both (potential) survey fatigue and (potential) differential interpretation of the survey instrument, perhaps the question regarding whether or not we can ever obtain the depth of data that we would like to have to enable the analysis of all of the possible influences upon traveller behaviour and social participation should be revisited (Axhausen, 1998). In addition, perhaps the ability of survey tools to record human behaviour unambiguously and without bias should be discussed more openly and where ambiguity might exist this should be more transparently reported and discussed.

#### *Considering secondary activities*

Despite the above reservations, during first stage analysis, the accessibility diary has succeeded in highlighting the importance of secondary activities to the understanding of people's activity participation. The paper now turns to discuss mean durations (the reader should bear in mind the above caveats regarding deviation from the mean).

On average, the data suggest that secondary activities 'add' 47.8 hours – *two days* – to a person's week. Not only does this highlight the importance of multi-tasking in modern lives, but also the types of activities (and time use 'efficiencies') that are likely to be unrecorded using traditional survey instruments, which only record single, primary activities.

Activity category	Primary mean	Secondary mean	Total
Communicating	265 (4.4)	1637 (27.3)	1902 (31.7)
Entertainment / recreation	1820 (30.3)	1684 (28.1)	3505 (58.4)
Formal activities	1864 (31.1)	107 (1.8)	1972 (32.9)
Household and personal	5102 (85)	857 (14.3)	5958 (99.3)
Information search	113 (1.9)	98 (1.6)	211 (3.5)
Shopping	140 (2.3)	81 (1.4)	221 (3.7)
Travel	642 (10.7)	164 (2.7)	806 (13.4)
All categories	9946 (165.8)	4628 (77.1)	14575 (242.9)

**Table 6. Activities as primary and secondary<sup>9</sup>**

<sup>9</sup> In minutes. Hours are in brackets. Total hours in one week equals 168. The reader should note that totals differ due to removal of 'other' and 'missing' categories and different calculations of the mean.

Table 6 compares records of time spent in each activity category, as primary, secondary and as a sum of both. A number of observations can be made from these basic calculations. An initial finding is that the 'ranking' of activities according to time spent changes when secondary activities are also considered. Notably, travel receives a lower ranking than communications activities: indeed, people spend more than twice the amount of time communicating than travelling, reversing the trend seen when just primary activities are considered. Travel is also on occasion recorded as a secondary activity.

In terms of recording different types of activities in diary studies, Table 6 shows the extent to which activity categories are judged by participants as primary or secondary. Where studies only record primary activities it seems likely that notably they will underreport 'communicating' as well as 'information search' and 'shopping'. 'Entertainment/recreation' is also substantially prevalent as a secondary activity although this may in part be explained by a high incidence of radio listening and/or television watching. Underreporting, then, would be most likely to affect those activity categories amenable to substitution effects, thereby underestimating the incidence and consequences of Internet use. It can further be suggested that the classes of activities that are likely to have been overstated in earlier studies are those that are unlikely to experience an Internet effect.

Thus, an important aspect of forthcoming analysis will be to disaggregate these activity categories into their component parts and to examine the importance of specific activities to the Internet-effects debate. A further consequence of the prominence of secondary activities is the consideration of time use efficiency. If Internet use enables greater time use efficiency, individuals may find the opportunity to gain higher levels of accessibility, beyond traditional substitution considerations.

#### *The suppression of increased physical mobility by increased virtual accessibility*

Much of the discourse concerning the relationship between personal travel and use of ICTs has focused on whether the latter substitutes for the former. By implication, it is inferred that in order for use of ICTs to positively contribute to problems of excess mobility and congestion there must be a resultant reduction in travel. However, previous research by the authors (mentioned above) adds credence to the hypothesis that virtual mobility via the Internet in fact substitutes for an *increase* in travel that would otherwise have been necessary to provide for the level of access to opportunities, services, social networks and other goods sought by individuals. This is particularly significant with relation to the mobility and exclusion debate. Thus, irrespective of whether virtual accessibility reduces an individual's level of mobility, it can serve to satisfy their aspirations for accessibility, such that there is no longer cause for them to pursue improved access through increases in physical mobility. The disaggregation of Internet-based activities, alongside records of the sociability of activities, should allow further exploration of this hypothesis.

#### *Personal characteristics*

Examination of the data by personal characteristics should allow further conclusions to be drawn regarding the variable Internet effects across the Internet-using population. Account can be taken of the four key factors of income, Internet experience, travel mode use and residential location in analysing participation in key activities according to activity durations. Such analysis should highlight the extent to which virtual mobility is substituting for or supplementing both existing and future travel demand, for which individuals and for which activities this is most relevant. In addition, the potential of virtual mobility to develop a reduction in social exclusion through greater participation in activities over time should become apparent.

Table 7 presents an example of the planned analysis, taking the example of the mean duration of email activity by 'virtual mobility readiness', measuring Internet experience by the year that the individual first used the Internet and the year in which they first used it at home. Table 7 suggests differences between email use according to Internet experiences.

Participants appear to demonstrate greater use of the Internet during initial connectivity, yet greater use with increasing time online at home, with the exception in both cases of those online for between 3-5 years, who exhibit reduced use of email vis-à-vis other groups. This population also stand out as having similar use of email as primary and secondary, in contrast to other groups, where a marked difference is evident. This is most clearly seen for participants who are new to the Internet, for whom email is rarely recorded as a secondary activity. Further analysis will examine alternative measures of Internet readiness to see if a similar pattern exists, alongside the three additional key variables of income, mode use and residential location.

Activity	Average min. per week – sample	Average min. per week – recorded	% sample doing at least once during week	Online 2 years or less (2002-2004) N=7	Online 3-5 years (1999-2001) N=22	Online 6-10 years (1994-1998) N=49	Online 10+ years (pre-1994) N=8
Email – primary	57	93	62	129	33	61	41
Email – secondary	55	81	69	16	35	67	74
Total	112	174	N/a	145	68	128	115
				N=20	N=33	N=31	N=5
Email – primary	57	93	62	79	49	48	86
Email – secondary	55	81	69	44	46	68	57
Total	112	174	N/a	123	95	146	143

Table 7. Average durations of key primary activities by time online<sup>10</sup>

#### *The composition of activity bundles in terms of online and offline time use*

Finally, certain activities in which individuals engage have a dominant functional purpose (for example, grocery shopping achieves the goal of replenishing household supplies). Meanwhile, other activities have a social purpose, that is, they provide the individual with stimuli to satisfy their 'wellbeing needs'. In the case of the latter activities, it is not necessarily the activity itself that meets the individual's needs, but, rather, the attributes of that activity. Thus, a social outing to the pub and online discussion in a chat room may have similar attributes in relation to social engagement and discourse, for some people. As such, it may not be sufficient to think in terms of direct online substitutes for offline activities, but instead to seek to better understand which attributes are important to individuals and which give rise to the 'bundles' of activities that they choose as part of their daily and weekly routines. Such bundles will constitute combinations of online and offline activities which, in turn, are able to meet the individuals' functional and social goals.

According to consumer theory, different bundles (in terms of their composition) can provide equal levels of satisfaction to the individual. Therefore, the individual is seen to be indifferent in terms of the attributes of the different activities within these bundles, given that the satisfaction outcomes remain equal. Applying this to physical and virtual accessibility, it follows that there can be bundles with more online activities and less offline activities, which are equally acceptable to the individual as bundles with less online activities and more offline activities, given equal satisfaction outcomes. Better understanding of how the attributes of different online and offline activities in different combinations can meet the functional and

<sup>10</sup> Durations are in minutes. Rows 1-3 are for time online – first ever use; rows 4-6 are for time online – first use in the home.

social needs of individuals could yield policy-relevant insights in terms of areas in which access could be better supported by investment in virtual mobility.

## Concluding remarks

This paper has introduced the challenging proposition that the established endeavours to understand the two-way interactions between ICT use and personal travel be extended to account for an important third dimension, namely social participation through engagement in activities. This proposition is important since it explicitly acknowledges that both ICT use and personal travel are undertakings *derived* from pursuit of access to opportunities, services, social networks and other goods. The proposition arises at a time when empirical evidence is still lacking, three-way interactions are changing in the face of an evolving 'information society' (and notably the arrival of the Internet and the associated virtual services it provides access to) and policy considerations surrounding both personal travel and social wellbeing have grown in importance.

To better understand the interactions between ICT use (specifically Internet use), personal travel and social participation therefore represents a formidable but important challenge. This paper has set out details of a study which is seeking to address this challenge. The study involves nearly 100 participants who, across time, are recording their time use by completing an accessibility diary. Detailed results and analysis will be provided in a revised version of this paper. However, preliminary analysis had already revealed some challenging issues to address both in relation to methodological considerations and understanding behaviour.

The overarching concern that arises in relation to methodology is best articulated by the following question: is it possible to design a survey instrument that is both sophisticated enough to truly capture understanding (and change) and simple enough to be interpreted and completed unambiguously and consistently by participants? In terms of understanding behaviour then it appears that hitherto we may have inadequately accounted for how individuals use their time in practice, presuming this to be a sequence of discrete single activities interspersed with episodes of travel. By recording secondary activities, this study is revealing that time use is more complex which in turn holds the prospect of shedding more light on how individuals use online and offline activities *in combination* to maximise the level and quality of access they can achieve and the satisfaction they attain.

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