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# Everyday travel and use of information and telecommunication technology at home

## An analysis of Norwegian data

**Randi Hjorthol**



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***Title:*** Everyday travel and use of information and telecommunication technology at home: an analysis of Norwegian data.

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***Summary:***
On the basis of the National Personal Travel Survey 1997/98 and a connected postal survey of the use of information- and communication technology at home, the relation between mobility and use of stationary communication has been studied. On the basis of these results we cannot see any substitutionary effects of the use of stationary technology at people's home on the use of mobile technology. Access to and use of information technology seems not to have a significant impact on travel activities in everyday life. Stationary communication seems to be a supplement to activities based on mobile technology. For people who work more than "normal" weekly working hours. stationary technology seems to give them greater flexibility in regard to where to work, but it does not necessarily reduce their travel activity. The spatial flexibility will also give a temporal flexibility, which means that work trips and other trips can be more dispersed over the day than is the situation today. The positive consequence can be a reduction in the rush-hour traffic; the negative is that it is more difficult to offer a good public transport service when travel needs are more spread in time.

***Tittel:*** Sammenhengen mellom dagliglivets reiser og hjemmebruk av informasjons- og kommunikasjonsteknologi - en analyse av norske data

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***Sammendrag:***
Med utgangspunkt i den nasjonale reisevaneundersøkelsen fra 1997/98 og en tilkoplet postal undersøkelse om bruk av informasjons- og kommunikasjonsteknologi i hjemmet, har vi undersøkt sammenhengen mellom reiseaktivitet og bruk av stasjonær teknologi i hjemmet. På basis av disse resultatene finner vi ikke at tilgang til og bruk av informasjons- og kommunikasjonteknologi i hjemmet har noen signifikant påvirkning på de daglige reisenes omfang. For de som arbeider lengre enn "normal" arbeidsuke gir informasjons- og kommunikasjonsteknologi mulighet for større fleksibilitet i forhold til hvor man kan arbeide, men det reduserer ikke nødvendigvis reisene. Den romlige fleksibiliteten gir også en tidsmessig fleksibilitet, som betyr at arbeidsreiser og andre reiser kan spres mer over dagen, enn tilfellet er i dag. Den positive konsekvensen av dette kan være en reduksjon av rushtrafikken. Den negative er at det vil bli vanskeligere å tilby et godt kollektivtilbud når reisebehovet er mer spredt i tid.

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# Preface

This report about the relation between everyday travel and use of information and communication technology is part of the work within the strategic institute programme –- *Travel behaviour - theory and method*, financed by the Research Council of Norway.

The objective of the programme is to develop theories and methods for the understanding of the population's travel behaviour and activity. This is vital knowledge in both transport and land use planning. The programme has four major issues:

1. Methodological development, critical evaluation of existing studies and testing alternatives, designed to develop a methodical platform for new studies on travel behaviour.
2. Studies of changes in lifestyle and the development of travel behaviour; for a better theoretical understanding of travel behaviour.
3. Welfare and barriers; designed to create a basis for the primary targets of transport policies and the demands of the transport system.
4. Sustainable mobility; limitations and possibilities; designed to focus on the potential for changes in transport patterns.

The analyses in this report are based on the national personal travel survey from 1997/98 and a connected postal survey on access and use of information and communication technology in people's home. The report is written by Randi Hjorthol, who also has been the project manager. Unni Lodden has adjusted the data files and done some of the data analyses. Head of the department, Jon Inge Lian, and professor Bertil Vilhelmson, the University of Gothenburg, has commented upon the report. Secretary Tove Ekstrøm is responsible for the final layout.

Oslo, November 1999
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# Content

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**Summary:**

# Everyday travel and use of information and telecommunication technology at home: an analysis of Norwegian data

**Will use of information-and communication technology reduce travel activities?**

When everyone has an Internet connection the need for travelling in everyday life will be reduced. We can work at home, groceries can be ordered on the net, we can get all the information we need, be entertained in different ways and there is no need to visit banks or travel bureaus. As a result there will be no problems with rush hour traffic, and the environmental problems related to the increasing car traffic will be significantly reduced. Or – will the reality be that the information- and communication technology are additional to other ways of communication, and for that reason only to a minor degree will replace everyday travel?

In this report we will give a review of research related to telecommuting and travel and present results from a national survey about use of information- and telecommunication technology at home. This survey is carried out in connection to the national personal travel survey from 1997/98. Together these surveys give an indication on the potential of the substitution of travelling by stationary communication.

**A brief review of earlier research**

Within the field of transport, the discussion of substitution of travel by electronic communication has been going on for more than twenty years. The energy crises at the beginning of the 1970s was the start of it all (Mokhtarian 1990). One of the first studies on telecommuting takes this as its point of departure (Nilles et al. 1976). In the debate on how to reduce environmental problems generated by road traffic, great hope has been placed on stationary means of communication bringing about reduced daily travel (Batten 1989, Capello et al. 1993, Engström et al. 1996).

Research on the substitution of travel has been concentrated on telecommuting and often in pilot and demonstration projects (Nilles 1991, Hamer et al. 1991, Henderson et al. 1996, Balepur et al. 1998). The results are not unambiguous. Although some projects have not resulted in reduced travel in total, car-use was reduced to a certain degree (Nilles 1991). In others, an increase in car-use was found due to more travel outside rush-time hours, but a reduction in the total length of car travel (Balepur et al. 1998). An experiment with 30 employees at the

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Ministry of Transport in The Netherlands resulted in a reduction in daily trips for telecommuters (Hamer et al. 1991). In a review of eight telecommuting programs, Mokhtarian et al. (1995) claim that the effect of telecommuting has to be analysed in relation to the total amount of daily travel, i.e. not just the journey to work. For instance, when travelling to work is eliminated, efficient travel chains can be broken and new patterns established. This might also change the travel patterns in the family or the household. What these researchers also found important was that the first telecommuters were different from employees in general. The first telecommuters had further to travel to work than employees on average, and for them the effect of telecommuting was greater than for people with shorter distances to work. This of course depends on the actual distance to travel of different occupational status groups in specific countries. In Norway, the average variation in length of travel between people in relation to lower and higher education and to occupational status is small (unpublished results from the national personal travel survey 1997/98).

Mokhtarian's (1998) conclusion based on the state-of-the-art of the relation between telecommuting and travel activity is that one cannot expect any significant reduction in travel activity by substituting telecommuting for work trips. She believes that information and communication technology will result in more flexibility in relation to everyday travel. A reduction in time travelling to work may for instance lead to more leisure travelling or shopping trips. Reduced car-use for one member of the family can lead to increased use for another.

In the long run, telecommuting and use of information and communication technology for organising everyday activities can have an impact on land-use. For example, a reduction in the number of trips to work per week can make acceptance of a long journey to work more palatable, and people may buy houses in more distant (and attractive) areas where prices are lower than in more central areas in towns and cities.

### The ownership of home computers

The results from our surveys show that there are significant differences between those who own home computers and those who do not in relation to gender, age, place of abode, education, income, employment and socio-economic status. More men than women own a computer, and the majority of all computer owners are between 25 and 55 years of age. People in older age groups are seldom owners. Education is an important variable that distinguishes computer-owners from non-owners. The proportion of people with higher education is greater among owners than among non-owners. The analysis also shows that among owners there is a greater proportion of people with high socio-economic status than among non-owners, and more cars and better access to cars in the households with computers than without.

### Private use of the home computer

Men use the computer for private purposes more than women do, and young people more than the elderly. For tasks carried out without an Internet connection there is also a significant difference between educational groups and after employment.

Those with low education and not gainfully employed use the home computer more for writing documents, correspondence, playing games etc than those with high education and within the work force. Education and employment are strongly related to age, and this is the main explanation behind the frequent use among these groups. Young men are the most frequent users of the computer for these purposes, and playing games is the most decisive activity.

Use of the home computer for private purposes, either with or without an Internet connection, bears little relation to mobility. Some of these activities can be considered analogous to trips related to various leisure activities and shopping. A correlation analysis, however, shows no significant negative relations between this type of use of the home computer and travelling, as we would have expected if stationary communication was substituted for travelling.

The correlation analysis shows that there is no relation between car-use, measured as trips as a driver and distance in kilometres per day, and use of the computer for private purposes (without an Internet connection). The correlation analysis between use of the computer for private tasks, the number of trips related to leisure and number of trips in total per day is not significant either. However, there is a positive relation between use of the computer for these purposes and number of trips related to private visits of friends and relatives for those who have an Internet connection. High frequency on one activity is correlated with high activity on the other. Use of stationary technology for private purposes is either additional to travelling or it is not related at all.

**Use of the home computer for paid work**

The most significant differences in application of the home computer for work purposes are found between men and women and between those with long weekly working hours and those with part-time work or those with “normal” working hours. Men’s use is about twice that of women’s use, and people who work 40 hours or more per week also use it twice as much as people with shorter working hours. Men are in the majority when it comes to working long hours, so those characteristics reinforce each other. It seems that work at home for these men comes in addition to their regular work at the workplace.

A correlation analysis shows, that there is no substitution of mobile communication, travelling, by use of stationary communication devices. People who use the computer at home in relation to their paid work have more car trips and total trips than people who do not use the computer for such tasks. Rather than being a substitute for mobile communication, stationary communication seems to be additional when the computer is used for tasks related to paid work.

**The travel patterns for groups with different access to a home computer and possibility to work at home**

We have compared daily travel patterns of employed groups with an annual income of NOK 200.000 or higher (to get the groups more homogeneous) with different access to home computers and possibilities for working at home. The results indicate that variations in travel patterns are fairly small. There is no significant difference in the total number of kilometres driven by car per day, even if there is a tendency for people who work mostly at home to travel a little shorter by car as a

driver. The same group has fewer work trips, but the total number of trips per day is the same as for the other groups with a home computer who do not work permanently at home, and even more than those without a home computer. This supports the hypothesis that a reduction in one type of journey or trip will be replaced by other kinds; for instance, work trips can be replaced by trips related to leisure or shopping. In this case we see that those who work at home have more chauffeuring trips than those without home computers, which could indicate that working at home might be an adjustment to a family situation with children.

**Discussion**

Considering the limitations related to the data sets, the results of our analyses show only to a very little extent any relation between ownership and use of a home computer and people's travel patterns. On the basis of these results we cannot see any substitutionary effects of the use of stationary technology at people's home on the use of mobile technology. Access to and use of information technology seems not to have a significant impact on travel activities in everyday life. Stationary communication seems to be a supplement to activities based on mobile technology.

For people who work more than "normal" weekly working hours, stationary technology seems to give them greater flexibility in regard to where to work, but it does not necessarily reduce their travel activity. The spatial flexibility will also give a temporal flexibility, which means that work trips and other trips can be more dispersed over the day than is the situation today. The positive consequence can be a reduction in the rush-hour traffic; the negative is that it is more difficult to offer a good public transport service when travel needs are more spread in time.

What these analyses also reveal is a strong relationship between the ownership of cars and the ownership of computers, and, as such, to a very high degree the same social groups who use the car and the computer. Men and high-income groups are more frequent users of the car than women and people with lower income. Men, high-income groups and people with high education more often own a home computer and have the possibility to work at home than people with low income and education.

If the possibility to flexibility regarding where and when to work continues to be a good for the privileged (high education/high income) in the future, it will be of great interest to know more about their preferences for living and also their daily activities in order to foresee the consequences for their travel patterns.

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**Sammendrag:**

# Sammenhengen mellom dagliglivets reiser og hjemmebruk av informasjons- og kommunikasjonsteknologi – en analyse av norske data

**Kommer bruk av informasjonsteknologi til redusere reiseaktiviteten?**

Når alle blir koplet til Internett kan behovet for trivielle reiser i hverdagslivet reduseres. Vi kan jobbe hjemmefra, matvarene kan bestilles over nettet, vi kan skaffe oss all den informasjonen vi trenger, vi kan la oss underholde på varierte måter og det er helt slutt på å oppsøke banker og reisebyråer. Dermed kan det bli slutt på rushtidsproblemene, og miljøproblemene knyttet til den økende biltrafikken vil kunne reduseres betydelig. Eller er det heller slik at hjemme-pc-en og informasjonsteknologien kommer i tillegg til andre måter å kommunisere på, at den bare i liten grad vil erstatte de daglige reisene?

I denne rapporten ser vi nærmere på hvilke erfaringer som er gjort med bruk av hjemme-pc i forhold til arbeid, hvilke transportmessige erfaringer man har med telependling eller fjernarbeid. Videre presenteres noen resultater fra en landsomfattende undersøkelse om bruk av informasjons- og kommunikasjons-teknologi hjemme, som er gjort i tilknytning til den nasjonale reisevaneunder-søkelsen fra 1997/98. Samlet gir disse to undersøkelsen mulighet til å kople reiseaktivitet med bruk av kommunikasjonsteknologi, noe som kan gi en indikasjon på i hvilken grad stasjonær kommunikasjon kan erstatte den mobile.

## Tidligere erfaringer

Diskusjonen om muligheten for å erstatte reiser med telekommunikasjon startet midt på 70-tallet i forbindelse med oljekrisen (Moktarian 1990). I forbindelse med miljødebatten har det blitt knyttet store forhåpninger til at informasjons-teknologien vil kunne redusere omfanget av problemene knyttet til vegtrafikken (Batten 1989, Capello 1993, Engström et al 1996). Det er særlig arbeidsreisen man ser for seg vil kunne reduseres i omfang ved at de yrkesaktive kan arbeide hjemme eller i såkalte nabolagssentre.

Forskning om substituering av reiser har først og fremst vært konsentrert om arbeidsreisene og ofte har den vært relatert til prøveprosjekter på forskjellige arbeidsplasser (Nilles 1991, Hamer et al 1991, Henderson et al 1996, Balepur et al 1998). Resultatene er ikke entydige. I noen av prosjektene ble bilbruken redusert,

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mens den totale reiseaktiviteten ikke gikk ned (Nilles 1991). Andre igjen fant en økning i bilbruk, som et resultat av at flere reiser foregikk utenfor rushtida, da det var lettere å komme fram med bil, men samtidig skjedde det en reduksjon i reiselengden (Balepur et al 1998). Et eksperiment blant 30 ansatte i det nederlandske samferdselsdepartementet resulterte i en reduksjon i antallet daglige reiser blant telependlerne (Hamer et al 1991). I en gjennomgang av åtte slike telependlingsprogrammer/prosjekter konkluderte Moktarian et al (1995) med at det var nødvendig å se på den samlede daglige reiseaktiviteten, ikke bare på arbeidsreisen alene. En effekt av at arbeidsreisen ble borte, var at etablerte reisekjeder forsvant, og at nye mønstre måtte etableres. Dette kunne igjen føre til at reisemønsteret for andre medlemmer av familien ble endret. Et annet aspekt som også ble framhevet ved evalueringen av disse pilotprosjektene var at de første telependlerne hadde lengre arbeidsreiser enn den gjennomsnittlige arbeidstakeren. Med mer ”vanlige” arbeidstakere vil effekten av substituering av arbeidsreisen bli mindre.

Moktarians (1998) konklusjon ut fra de erfaringer man har med forholdet mellom telependling og reiseaktivitet til nå er at man ikke kan forvente en stor reduksjon i reisene, hvert fall ikke på kort sikt. Hennes mening er at informasjons- og kommunikasjonsteknologi først og fremst vil resultere i større fleksibilitet hva angår de daglige reisene. Det vil bli mer kombinasjon av hjemme-på jobb, og det vil bli mer reising til andre aktiviteter.

På lengre sikt kan en tenke seg at bruk av denne typen teknologi og telependling kan ha betydning for hvor ulike grupper i befolkningen ønsker å bosette seg og dermed også for arealbruken. En reduksjon i antallet arbeidsreiser i løpet av en uke kan gjøre det mer akseptabelt å ha en lang arbeidsreise, slik at flere bosetter seg i områder lengre fra sentrum av byene der prisene er lavere. Man får færre, men lengre arbeidsreiser, og vinninga går opp i spinninga.

### En undersøkelse både om reiser og bruk av hjemme-pc

I den nasjonale reisevaneundersøkelsen som ble gjennomført i 1997/98 ble det spurt om intervjupersonen hadde pc i sitt hjem og om hun eller han kunne tenke seg å svare på et spørreskjema om bruken av tele- og informasjonsteknologi i hjemmet.

Disse to datasettene, reisevaneundersøkelsen, som viser det daglige reiseomfanget, formål og transportmiddelbruk, og pc-undersøkelsen, som gir informasjon om bruk av den stasjonære informasjonsteknologien, gjør det mulig å analysere forholdet mellom stasjonær og mobil kommunikasjon. Poenget med denne koplingen er å forsøke å se totaliteten av hverdagslivets aktiviteter og reiser i relasjon til bruk av elektronisk kommunikasjon og pc hjemme i forskjellige grupper av befolkningen.

### PC-hushold er de samme som to-bil-hushold

Det er klare forskjeller mellom de som har og de som ikke har hjemme-pc i husholdet. Det er flere menn enn kvinner som eier hjemme-pc, og majoriteten av eiere er mellom 25 og 55 år. De eldre aldersgruppene har sjelden hjemme-pc. Andelen eiere har oftere høy utdanning, inntekt og yrkesstatus enn ikke-eiere.

Sammenliknes de som har hjemme-pc med de som har to eller flere biler i husholdet, viser det seg at dette på mange måter er de samme gruppene. Det er flere menn enn kvinner som tilhører slike hushold, de er mellom 25 og 55 år og de har relativt høy inntekt. Der de skiller seg noe fra hverandre er i forhold til yrkesstatus og utdanning. De som har hjemme-pc har noe høyere yrkesstatus og utdanning enn de som tilhører to-bil-husholdet.

Det er med andre ord en ganske skjev fordeling av hjemme-pc i befolkningen. De som har god tilgang til bil har også god tilgang til informasjonsteknologi hjemme. Fra tidligere forskning vet vi at god tilgang til bil også betyr at bilen brukes relativt mye.

**Menn og unge bruker pc-en mest til private formål**

I undersøkelsen ble intervjupersonene spurt om hvor ofte de hadde brukt pc-en til forskjellige formål i løpet av siste uke. Det ble skilt mellom bruk som ikke krever en nettilkopling og det som krever det og mellom privat bruk og bruk knyttet til betalt arbeid.

For å undersøke hvilken betydning kopling til nettet har for alle typer bruk, har vi skilt mellom dem som har og dem som ikke har i analysene av bruk.

De som har nett-kopling bruker hjemme-pc-en mer enn de som ikke har det til formål som ikke krever at det er en kopling, slik som å skrive, bruke regneark, grafikk, spill osv. I gjennomsnitt bruker de med Internett-tilknytning pc-en 9 ganger pr uke til private formål, mens de som ikke har nettkopling bruker den 5 ganger pr uke. Menn bruker den mer enn kvinner og unge oftere enn eldre. Til slike private formål er det de som ikke er yrkesaktive og med grunnutdanning som er de ivrigste brukerne. De to siste forholdene er først og fremst knyttet til alder. Det er de unge, og i første rekke unge menn som er hyppige brukere av hjemmedataen til slike formål, og først og fremst er det spill som er den mest vanlige aktiviteten. Forskjellen mellom kvinner og menn blant de yngste, fra 13 og opp til 25 år er stor. Blant dem som er eldre er forskjellene små.

Når det gjelder bruk av pc-en til å kommunisere med omverdenen, slik som å sende eller få e-post, bestille varer og tjenester, søke etter informasjon eller deltakelse i diskusjonsgrupper, ligger omfanget av denne aktiviteten på ca 8 ganger pr uke. Her finner vi også klare kjønns- og aldersforskjeller, men ingen forskjeller mellom yrkes- og utdanningsgrupper.

Bortsett fra den siste typen av aktiviteter, er det ingen klare forbindelser til reiseaktivitet. Noen kan relateres til fritid og innkjøp/service, og dermed til en eventuell reduksjon i den typer av reiser. For å få en indikasjon på om det er en slik sammenheng, om hyppig bruk av pc til private formål reduserer reiseaktiviteten mht fritid og innkjøp, er det gjort korrelasjonsanalyser av sammenhengen mellom daglig reiseomfang og ukentlig pc-bruk.

Disse analysene viser at det er ingen signifikant negativ sammenheng mellom reiser og bruk av pc, slik som det skulle har vært dersom den mobile kommunikasjonen skulle vært erstattet av den stasjonære kommunikasjonen. Det ser ut til at bruk av stasjonær teknologi for private formål kommer i tillegg til andre aktiviteter, og har dermed lite med reiser å gjøre.

**Bruk knyttet til lønnet arbeid reduserer ingen reiseaktivitet**

Det har vært vist stor interesse for en potensiell reduksjon i arbeidsreisene ved bruk av informasjonsteknologi. I vår undersøkelse ble det også spurt hvor mange ganger pr uke intervjupersonen brukte hjemme-pc-en i tilknytning til lønnsarbeid. Vi skilte mellom den type arbeid som kan gjøres uten nett-kopling og den som man trenger nett-kopling for å gjøre.

Den typiske brukeren av hjemme-pc-en til dette formålet er mann, har en arbeidsuke som er 40 timer eller lenger, har høy utdanning og yrkesstatus. For de som ikke har nettkopling er brukerfrekvensen for oppgaver som ikke trenger tilkopling to ganger pr uke, mens den er ca fem ganger pr uke for de som har nettilgang. For nettrelaterte oppgaver er frekvensen fire ganger pr uke.

Heller ikke for denne bruken av informasjonsteknologien finner vi noen negativ sammenheng med reiseaktiviteten. Det er snarere slik at de som har nettilgang og bruker pc-en mye også har stor reiseaktivitet. Dette gjelder særlig den bruken som omfatter skriving, numerisk og grafisk bruk, men det er også sammenheng mellom utadrettet kommunikasjon og antall km med bil som sjåfør på den måten at lange reiser går sammen med hyppig bruk av kommunikasjonsteknologien. Det kan se ut til at muligheten for bruk av info- og kommunikasjonsteknologien øker fleksibiliteten for de som er yrkesaktive.

**Liten forskjell i reisemønstre for folk med forskjellige muligheter til å arbeide hjemme**

For å se litt nærmere på hva muligheten til å arbeide hjemme har for organisering av reisemønstrene mer generelt, ikke bare for arbeidsreisene, har vi sammenliknet de viktigste reiseaktivitetene for fire grupper av yrkesaktive. Gruppene er delt inn etter muligheten til å kunne arbeide hjemme og tilgang til hjemme-pc. For å gjøre gruppene mer homogene på andre områder, har vi valgt ut dem som har en årsinntekt på kr 200.000 eller høyere.

Det er ingen signifikant forskjell i antall km kjørt med bil pr dag mellom disse gruppene. Det er en tendens til at de som mesteparten av tiden arbeider hjemme kjører noe kortere med bil enn de andre gruppene. Den samme gruppen har naturlig nok færre arbeidsreiser enn de tre andre gruppene, men samlet sett har de like mange reiser som de to andre gruppene som også har hjemme-pc, og flere enn de som ikke har hjemme-pc. Dette resultatet understøtter hypotesen om at en reduksjon i en type reiser kan føre til en økning i andre typer av reiser, f eks kan arbeidsreiser erstattes av flere fritids- og innkjøpsreiser. I dette tilfellet er det slik at de som arbeider hjemme har flere omsorgs/følgereiser enn dem uten hjemme-pc, noe som indikerer at det å jobbe hjemme kan være en tilpasning til en familiesituasjon med barn.

**Større fleksibilitet i tid og rom**

Resultatene fra denne undersøkelsen viser at det i liten utstrekning er noen sammenheng mellom eie og bruk av hjemme-pc og de daglige reisemønstrene. På basis av disse resultatene kan vi ikke si at det er noen substitusjonseffekt mellom de

to typene av teknologi. Den stasjonære kommunikasjonen ser ut til å være et supplement til aktivitetene basert på mobilitet.

Den hjemmebaserte datateknologien gir større fleksibilitet for de som arbeider mer enn "normal" uke når det gjelder hvor de kan arbeide. Denne romlige fleksibiliteten gir også en tidsmessig fleksibilitet som betyr at arbeidsreisen i større grad enn i dag kan spres over dagen. Den positive konsekvensen kan være en reduksjon i rushtrafikken. Den negative er at det er vanskeligere å gi et godt kollektivtilbud dersom reisebehovet er mer spredt ut i tid.

Disse analysene viser også at det er de samme gruppene som har god tilgang både til bil og hjemme-pc. Menn og personer med høy inntekt bruker bil mer enn kvinner og de som har lav inntekt. Menn, grupper med høy inntekt og utdanning eier hjemme-pc og har mulighet til å jobbe hjemme enn de som har lav utdanning og inntekt. Muligheten for fleksibilitet mht hvor og når man kan jobbe, ser ut til å følge allerede eksisterende segmenter i arbeidslivet. Et viktig spørsmål er hvordan de forskjellige segmentene vil utvikle seg og størrelsen av dem.

Hvis muligheten til fleksibilitet i forhold til tid og rom vil være et gode for de mer priviligerte (høy inntekt/utdanning) også i fremtiden, vil det være svært interessant å vite mer om hvilke preferanser disse gruppene har både i forhold til boligforhold og de daglige aktivitetene.

# 1 Introduction

Broadly defined, a distinction can be made between two types of communication and the exchange and handling of information. The first is when the actor who wants to communicate or collect/exchange information or goods/services travels to where the activity is to take place or where the information can be obtained or delivered. This can be called *mobile communication*. The actor has to move (or be moved) for the task to be completed, and a human being is the carrier of the information (Salomon 1996). The other type, *stationary communication*, is when the actor obtains information/goods/services or communicates from where s/he is situated. There is also a third possibility – a combination of mobile and stationary communication; for instance, use of a mobile telephone in the car, on a train, in an aeroplane, etc. In this paper, however, I concentrate on the two main types.

A different technology is needed for each of these two forms of communication. Usually, some sort of transport is needed with the mobile form – very often a car. In Norway, about two-thirds of all daily travel is done by car (Hjorthol 1999), which is typical of most western societies. The car is a type of technology which during the last thirty years has made mobile communication through travel possible for a majority of the population, and at the same time a very important catalyst for the development of land-use in both rural and urban areas.

The stationary form of communication requires telecommunication equipment of various kinds, e.g. telephones, facsimile machines and computers with Internet connections. Today, most Norwegian households have telephones, and nearly half of the population have a computer at home (Vaage 1997). In 1996, about 10 per cent of households also had a connection to the Internet (Vaage 1997).

Both transport technology and information and communication technology have "made the world smaller". The concept *time–space compression* (Harvey 1989) is descriptive of this phenomenon. It is easy to move quickly in time and space, physically and/or electronically. Electronic communication has virtually eliminated the significance of both time and space. In combination, these two forms of technology make it possible to organise everyday life and employment in new ways in relation to time and space.

Transport and information and communication technology exist side by side, and may in principle substitute one for the other. Within the field of transport, the discussion of substitution of travel by electronic communication has been going on for more than twenty years. The energy crises at the beginning of the 1970s was the start of it all (Mokhtarian 1990). One of the first studies on telecommuting takes this as its point of departure (Nilles et al. 1976). In the debate on how to reduce environmental problems generated by road traffic, great hope has been placed on stationary means of communication bringing about reduced daily travel (Batten 1989, Capello et al. 1993, Engström et al. 1996).

In debates on planning and policy, replacing travelling to work with telecommuting (e.g. working remotely with the help of a computer either from the home of the employed or from neighbourhood centres) is gaining ground. Based on a paradigm of modernity, one belief is that new and modern technology, partly or in full, can take over for the old, e.g. that information and telecommunication to some degree will replace physical travel.

Another way of looking at these two types of technology is to see them as complementary, i.e. each generating more use or different use of the other, or they can be independent of each other, i.e. additional or one supplementing the other.

Research on the substitution of travel has been concentrated on telecommuting and often in pilot and demonstration projects (Nilles 1991, Hamer et al. 1991, Henderson et al. 1996, Balepur et al. 1998). The results are not unambiguous. Although some projects have not resulted in reduced travel in total, car-use was reduced to a certain degree (Nilles 1991). In others, an increase in car-use was found due to more travel outside rush-time hours, but a reduction in the total length of car travel (Balepur et al. 1998). An experiment with 30 employees at the Ministry of Transport in The Netherlands resulted in a reduction in daily trips for telecommuters (Hamer et al. 1991). In a review of eight telecommuting programs, Mokhtarian et al. (1995) claim that the effect of telecommuting has to be analysed in relation to the total amount of daily travel, i.e. not just the journey to work. For instance, when travelling to work is eliminated, efficient travel chains can be broken and new patterns established. This might also change the travel patterns in the family or the household. What these researchers also found important was that the first telecommuters were different from employees in general. The first telecommuters had further to travel to work than employees on average, and for them the effect of telecommuting was greater than for people with shorter distances to work. This of course depends on the actual distance to travel of different occupational status groups in specific countries. In Norway, the average variation in length of travel between people in relation to lower and higher education and to occupational status is small (unpublished results from the national personal travel survey 1997/98). One of the conclusions from a scenario project about teleworking in Norway is that telecommuting will be most frequent in the central urban regions, caused by the occupational structure (Jacobsen et al 1996).

Mokhtarian's (1998) conclusion based on the state-of-the-art of the relation between telecommuting and travel activity is that one cannot expect any significant reduction in travel activity by substituting telecommuting for work trips. She believes that information and communication technology will result in more flexibility in relation to everyday travel. A reduction in time travelling to work may for instance lead to more leisure travelling or shopping trips. Reduced car-use for one member of the family can lead to increased use for another.

In the long run, telecommuting and use of information and communication technology for organising everyday activities can have an impact on land-use. For example, a reduction in the number of trips to work per week can make acceptance of a long journey to work more palatable, and people may buy houses in more distant (and attractive) areas where prices are lower than in more central areas in towns and cities.

For both the stationary and the mobile form of communication, good access to technology gives people possibilities for substitution, complementary and supplementary use.

The purpose of this paper is to carry out a comprehensive analysis of the combination of stationary and mobile communication, with everyday life as the point of departure. My intention is to present the relation between the private ownership and use of both stationary and mobile technology. I will try to see the totality of everyday activities and travel in relation to the use of electronic communication and computers for different purposes in people's homes.

The questions I address are whether intensive use of one form of technology reduces use of the other, or vice versa, whether intensive use of one form goes together with intensive use of the other. Perhaps there is no relation at all between the use of these two forms of communication technology. I explore how ownership and use of the two technologies are distributed among different social groups. How do different groups in the population use them and for what activities and purposes; which groups are familiar with them and their use? For both types of technology I assume that income is important for ownership and thus also for use. From earlier studies on transport and travel we know that gender is still an important variable when it comes to use of the car; men own and use the car more than women do. It also seems that interest in technology in general is greater among boys/men than among girls/women, a fact which is also relevant for information and communication technology (Vaage 1998). Competence and mastering are strong aspects of this type of technology. Some of this competence is related to education; people with higher education are more likely to use this type of technology in their jobs than people with lower competence. The impact of income, education and gender is discussed in section 3.

The home computer will have different areas of application depending on the equipment. The simplest form – a computer with no Internet connection – can be used for writing, for carrying out numerical calculations, for entertainment and for processing and storing information. A CD-ROM player increases the value of information-seeking and entertainment.

Use of the home computer can be characterised according to different dimensions, and the activities or tasks carried out can be private or related to paid work/employment. Private tasks can be divided into entertainment, information and household work – entertainment and information to the benefit of oneself, household work to the common benefit of the household.

The computer connected to the Internet allows communication with the "surrounding world". This can be divided according to activity or purpose. Private use might be social contacts with friends, ordering goods or services, obtaining different forms of information, and so on. Use in employment/paid work can also take different forms, e.g. writing, making calculations, information-seeking, attending discussion groups, etc.

The use of a car or other means of transportation can be related to activities in analogous categories, and the trip will be the analytical category in this context. The work trip is related to production, as is the business trip, which can be compared to information-seeking and communication with colleagues or discussion groups on the Internet. Shopping for groceries belongs in the sphere of reproduction and is an activity carried out for the benefit of the household. Leisure trips also belong in the sphere of reproduction, but are mainly an activity carried out for one's own benefit.

The paper is in six parts. Following the Introduction and a section on the data and methodology, I present analyses of the ownership of both stationary and mobile technology equipment before taking a closer look at the use of the technology among different groups. In section 5, I present the results of the analysis about the relationship between the possibility for "home work" and the amount of travel activity and travel patterns. Finally, in section 6, there is a short discussion of the results.

# 2 Data and methodology

In 1997/98, the third Norwegian national personal travel survey was carried out. A random sample of about 8800 people, 13 years of age or above, were interviewed by telephone about their daily travel activities, household characteristics and such personal information as education, income, transport resources, employment, and so on. At the end of the interview the interviewee was asked if the household owned a computer, and, if so, whether s/he would agree to fill out a questionnaire about the use of information and telecommunication equipment at home.

Of the total sample of about 4500, 51 per cent said they owned a home computer; 3400 agreed to fill out the questionnaire and, of these, 81 per cent actually returned it. With some reduction because incomplete questionnaires, we arrived at a net sample of 2500 persons, 55 per cent of whom own a home computer.

These two sets of data, the personal travel survey and the survey about the ownership and use of information and telecommunication equipment at home, make it possible to analyse the relation between stationary and mobile communication.

The personal travel survey comprises nine main subjects: introduction, access to transport resources for the interviewed person and for the household, activities and travel the day before the interview (purpose, length, time-use, transport mode, when and where the trip started and ended), long trips (100 km or longer during the previous month), employment/occupational status, the journey to work, education and employment of the spouse, information about the household, information about the interviewee.

The information and telecommunication survey consisted of six main subjects: type and number of computers at home, other types of information and telecommunication devices, use of computers at home, use of computers for out of home communication (both privately and related to paid work), use of other telecommunication equipment (telephone and telex) and the amount of home-based paid work.

The analyses in this paper are concentrated on daily travel activities; long trips are not taken into consideration. We also concentrate on the use of computers and pay some attention to the use of telecommunication devices such as telex and telephone.

Information on use of the home computer is limited to *the week before* the respondents received the questionnaire, the travel activity to *one* day about a week before (when the telephone interview was carried out). The consequence of this is that travel activities and use of the home computer do not cover the same days. The results therefore have to be interpreted on an aggregate level.

# 3 Access to stationary and mobile communication technology, the ownership of computers and cars

Even though cars and computers today are commonly found among most social groups in the population, there is a correlation with income. A Norwegian study on the development of use of different media shows that home computers are more common among high-income households than among low-income households (Vaage 1998). A Swedish study on information technology and transportation also shows a relation between access to computers at home and income, but contrary to the Norwegian results a very high proportion among the lowest income group have access to a home computer (SIKA 1998). The explanation is that students and young people very often have a home computer but a low income. What both the Swedish and the Norwegian studies show is that elderly people very seldom have access to home computers. Surveys of both private consumption and personal travel show that high-income groups have better access to private cars than low income groups (SSB 1993, Hjorthol 1999).

I first compare between the respondents who have a home computer and those who do not, and relate this to respondents with no car in the household and to those with two cars in the household. What are the characteristics of those groups?[1]

[1] Respondents with a home computer but who did not participate in the postal enquete are not included in this analysis.

*Table 3.1. Characteristics of groups with and without home computers and with no car and two cars in the household (%).*

| **Variables** | **Without home computer** | **With home computer and respondent of the questionnaire** | **No cars in the household** | **Two cars in the household** |
|---|---|---|---|---|
| *Gender*: | *** | | *** | |
| Male | 45 | 55 | 32 | 53 |
| Female | 55 | 45 | 68 | 48 |
| *Age*: | *** | | *** | |
| 13-17 years | 4 | 10 | 5 | 9 |
| 18-24 years | 6 | 9 | 10 | 7 |
| 25-34 years | 20 | 24 | 18 | 20 |
| 35-44 years | 15 | 27 | 9 | 27 |
| 45-54 years | 16 | 21 | 9 | 22 |
| 55-66 years | 18 | 8 | 14 | 12 |
| 67+ | 22 | 2 | 36 | 3 |
| *Education*: | *** | | *** | |
| Elementary school | 30 | 15 | 36 | 20 |
| High school/college | 46 | 37 | 38 | 43 |
| University lower level (BA) | 12 | 19 | 11 | 16 |
| Universty, higher level | 11 | 27 | 12 | 19 |
| Unknown | 2 | 2 | 3 | 2 |
| *Household income (NOK 1000)*: | *** | | *** | |
| Under 100 | 9 | 2 | 28 | 1 |
| 100-199 | 18 | 4 | 29 | 2 |
| 200-299 | 25 | 13 | 25 | 10 |
| 300-399 | 18 | 19 | 9 | 20 |
| 400-499 | 15 | 22 | 3 | 24 |
| 500+ | 14 | 41 | 5 | 43 |
| *Proportion employed* :*** | 57 | 71 | 42 | 80 |
| *Socioeconomic status*: | *** | | *** | |
| Manual workers. | 33 | 32 | 23 | 36 |
| Non-manual workers | 14 | 25 | 12 | 21 |
| Profes., high level whitecol. | 8 | 18 | 5 | 16 |
| Owners | 4 | 5 | 2 | 7 |
| Student | 5 | 11 | 9 | 8 |
| Others | 35 | 9 | 50 | 12 |

*** Significant for p<0.000.

There are significant differences between those who own home computers and those who do not in relation to gender, age, place of abode, education, income, employment and socio-economic status (Table 3.1). More men than women own a computer, and the majority of all computer owners are between 25 and 55 years of age. People in older age groups are seldom owners. Education is an important variable that distinguishes computer-owners from non-owners. The proportion of people with higher education is greater among owners than among non-owners. The analysis also shows that among owners there is a greater proportion of people

with high socio-economic status than among non-owners, and more cars and better access to cars in the households with computers than without.

The characteristics of those who have no cars in the household and those who belong to households with two cars are presented in Table 3.1. In relation to gender, age, household income and socio-economic status, the social compositions of those belonging to two-car households and of those with a home computer are very much alike. Computer-owners in two-car households are more likely to be men than women; they are in middle age, with high household income and relatively high occupational status.

A correlation analysis reveals a relationship between the ownership of cars and computers in the household of 0.244 (significant at the 0.01 level (2-tailed)). Both the car and the home computer are technical devices that are part of the same field of consumption. They are both correlated with household income, and are individual equipment more typical of men, young middle-aged people, and those with high income and education.

*Table 3.2. Characteristics of home computer owners with different standards of equipment (%).*

| Variables | With 586/Pentium or Mac | Without 586/Pentium or Mac | With Internet connection | No Internet connection |
|---|---|---|---|---|
| Men | 57 | 52 | 59 | 52 |
| 25 - 34 years | 25 | 21 | 26 | 21 |
| University, high level | 19 | 17 | 19 | 17 |
| NOK 500+household income | 45 | 34 | 49 | 33 |
| Employed, weekly >+40 hours | 20 | 14 | 21 | 14 |
| High occupational status | 19 | 17 | 19 | 17 |
| Number | 1166 | 1605 | 1477 | 1294 |

There are also differences within the computer-owner group in relation to standard of equipment. In Table 3.2 the sample is divided into those with a high quality computer (596/Pentium/Mac) and those without, and those with and without an Internet connection. The table shows that men, people with high level university education, those with high occupational status and in the age group between 25 and 35 years are more likely to have higher standards of computer equipment than others.

Multivariate analyses show that income, age and gender have the greatest impact when it comes to both the standard of the computer and on Internet connection among those who already have a computer (gender is not significant at the 5 per cent level in the analysis of computer standard in Table 3.3)

*Table 3.3. The probability of having a high quality computer among those who have a computer. Logistic regression.*

| Variables | B | S.E | Sig |
|---|---|---|---|
| Gender (male=1, female=0) | 0.1547 | 0.2920 | 0.0904 |
| Age | –0.0195 | 0.0041 | 0.0000 |
| Household income | 0.1346 | 0.0345 | 0.0001 |
| Education, <=9 yrs 1) | –0.0628 | 0.1751 | 0.7200 |
| Education, <=12 yrs 1) | –0.2249 | 0.1205 | 0.0620 |
| Education, <=15 yrs 1) | –0.2125 | 0.1251 | 0.0895 |
| Manual workers 2) | 0.1244 | 0.1753 | 0.4778 |
| Non-manual workers 2) | 0.3477 | 0.1751 | 0.0471 |
| High level white collar workers, professionals 2) | 0.2534 | 0.1864 | 0.1740 |
| Owner of business, farmer, etc. | 0.2918 | 0.2489 | 0.2410 |
| Students, pupils 2) | 0.3920 | 0.2646 | 0.1385 |
| Constant | 0.2920 | 0.2965 | 0.3247 |

N = 2190
-2 Log Likelihood = 2910,142
Reference categories:
1) Education >= 16 years
2) Housewives, unemployed and others not in the work force.

The probability of having a high quality computer increases with household income and with decreasing age among those who own a computer. As Table 3.3 shows, there is also a very strong tendency for men more so than women to have a high standard of equipment. This is parallel to access of the car. The probability of always having access to a car is much higher if you are a man and have a high income (Hjorthol 1999). Contrary to the relation between computer standard and age, access to cars increases up to a certain age (see Table 3.1).

The probability of having an Internet connection is strongly related to both income and age (Table 3.4). Gender, too, has a significant impact. Men more often than women have a computer with an Internet connection. The analysis also shows that people with middle-level education less often have an Internet connection than people with a high-level university education. The reason there is no significant difference between people with lowest and highest education is explained by age. More than 50 per cent of the respondents on the lowest educational level are under 18 years and still living with their parents.

The ownership of devices for both stationary and mobile communication, the computer and the car are, not surprisingly, related to income. Even though most households own a car, both the number of cars in a household and access to a car are dependent on income level. The car, however, is a type of technology that has been in use for many years and, as such, has a major impact on the organisation of people's everyday lives. For many daily activities it is difficult to manage without a car, and, for many people, car-use has become a habit which they don't reflect

on. Very often the car is used even if other means of transportation are cheaper and could be used more economically in relation to time.

*Table 3.4. The probability of having an Internet connection among those who have a computer. Logistic regression.*

| Variables | B | S.E | Sig |
|---|---|---|---|
| Gender (male=1, female=0) | 0.3079 | 0.0911 | 0.0007 |
| Age | –0.0203 | 0.0041 | 0.0000 |
| Household income | 0.2187 | 0.0351 | 0.0000 |
| Education, <=9 yrs 1) | –0.1561 | 0.1729 | 0.3667 |
| Education, <=12 yrs 1) | –0.2616 | 0.1194 | 0.0284 |
| Education, <=15 yrs 1) | –0.3830 | 0.1244 | 0.0021 |
| Manual worker 2) | –0.1667 | 0.1780 | 0.3491 |
| Non-manual worker 2) | –0.1387 | 0.1771 | 0.4337 |
| High level white collar workers, profes.2) | –0.2022 | 0.1882 | 0.2825 |
| Owner of business, farmer, etc. | –0.0337 | 0.2494 | 0.8924 |
| Student, pupil 2) | –0.3194 | 0.2615 | 0.2218 |
| Constant | –0.1908 | 0.2987 | 0.5229 |

N = 2190
-2 Log Likelihood =2940,080
Reference categories:
1) Education >= 16 years
2) Housewives, unemployed and others not in the work force.

The home computer is a new technology compared to the car. The fact that it is not that common and not yet as important in everyday life as the car, is one reason why income is still so significant for the ownership of a home computer. The computer and an Internet connection are not seen as necessary devices in the same way that a car is.

There are gender differences related to the ownership of cars and computers. Earlier research on transport shows that women have less access to cars than men have (Rutherford et al. 1988, Hanson et al. 1985, Hanson et al. 1995, Kranz 1997, Hjorthol 1998). This is so in the case of both the USA and Europe, including Scandinavia, and the result is that women use the car less than men do, and partly for carrying out different activities and tasks. In families with only one car, the husband uses it most (Hjorthol 1998). While men use the car for most activities, the car-use of women is more related to tasks for the household, such as driving children to and from kindergarten and leisure activities and for household shopping.

Use of communication and information technology is common for both women and men in most work-places. However, within occupations where information technology is applied, men dominate the positions which demand high technological competence, while women have positions with lower competence demands (Nybakk 1991).

The share of females reading computer science at the University of Oslo in 1990 and in 1995 was 25 per cent. The female share of civil engineers with subjects connected to informational technology was 14 per cent in 1990 and 9 per cent in 1995. Surveys of women who study computer science show that they are uncomfortable in this educational environment and feel neglected by the professors (Håpnes 1992, Kvande et al. 1990).

Research has revealed that within the same occupation women to a greater extent than men tend to feel more alienated in relation to communication technology (Lie 1993). It is argued that women experience the culture associated with this technology unfamiliarly (Turkle 1988). In its most extreme version it appears as a masculine world where a culture of hacking and of mastering the subtleties of the machine are dominant.

This is analogous to the car, which can also be seen as a medium for mastering. Maintaining and repairing cars demands competence. Research within the transport field gives an indication of the differences between men's and women's perceptions of the car (Sandford 1983, Rosengren 1993, Hagman 1985, Hjorthol 1998). Both types of technology can be seen as status symbols. The machine and the car are reflections of the owner by representing quality. An advanced computer or an exclusive car gives the owner a hallmark. These types of technology have a double meaning; they are both a tool/instrument and a cultural object with a social meaning, which might be perceived differently for men and women. Within this area, mastering and status are probably more important for men than for women and might be one of the reasons that men more often than women have more advanced computer equipment at home also when controlled for income and education.

# 4 The use of computers and cars

In the postal survey on the use of information and communication technology at home, questions about the use of the computer were divided into different categories. There are two important dimensions: private tasks versus paid work and use without versus with an Internet connection. Private use without an Internet connection is divided into five categories: writing documents, letters, etc., numeric calculation, graphics, illustration, etc., games and other tasks. With the exception of games, these same categories also apply in the case of paid work. For private use with an Internet connection the tasks are divided into six categories: send/receive e-mail from friends and relatives, send/receive e-mail from others/attend discussion groups, use the Internet for information, etc., order goods/services, send/receive documents, and other tasks. Besides e-mail contact with friends/relatives the categories are the same for the use of the home computer in relation to paid work. The respondents were asked to report how many times they carried out the different tasks during the previous week. If they had not used the computer they were asked to indicate how long time it was since they had used it. This could mean memory problems, but these will probably be more pronounced among high frequency users and lead to underestimation of their use.

In order to get a general view of the differences that we might find between those who own a home computer and those who don't, we start with the use of the car by the different groups.

## 4.1 Car-use and mobility related to ownership of a home computer

To get a general indication of the relationship between stationary and mobile communication we will take a closer look at the use of car and the general mobility level among those who own and those who do not own a home computer. As a measure on mobility, we have taken the number of car trips as a driver per day, the distance travelled (in kilometres) by car as a driver and the total numbers of trip per day.

Owning a home computer has no bearing on mobility in total or travelling by car – neither the number of trips nor the distance in kilometres (Table 4.1). The situation is not that people who own a computer travel less than those who do not, but rather the other way around. Only for a few groups are there differences which can indicate some substitutive effect, and these are of too little significance to be commented on. Ownership of a computer obviously has no relation to mobile communication. It is necessary to relate it to the use of the computer.

*Table 4.1. Number of trips and kilometres by car as a driver per day, total number of trips per day after ownership of home computer in different groups after gender, age, education, income and place of abode.*

| Variables | No. of trips as car driver | | Km per day by car as a driver | | Total no. of trips per day | |
|---|---|---|---|---|---|---|
| | Owner of home computer | Not owner | Owner of home computer | Not owner | Owner of home computer | Not owner |
| **Gender:** | | | | | | |
| Male | 1.9 | 1.8 | 27 | 28 | 3.4 | 2.9 |
| Female | 1.5 | 1.1 | 13 | 12 | 3.3 | 2.6 |
| **Age:** | | | | | | |
| 18-24 yrs | 1.4 | 1.3 | 14 | 19 | 3.5 | 3.3 |
| 25-34 yrs | 1.7 | 2.0 | 25 | 28 | 3.3 | 3.5 |
| 35-44 yrs | 2.1 | 2.0 | 24 | 29 | 3.4 | 3.5 |
| 45-54 yrs | 2.0 | 1.7 | 23 | 23 | 3.4 | 2.8 |
| 55-66 yrs | 1.6 | 1.3 | 21 | 18 | 3.0 | 3.1 |
| 67 + yrs | 1.4 | 0.7 | 20 | 8 | 2.9 | 1.8 |
| **Education:** | | | | | | |
| Compulsory school (9 yrs) | 0.8 | 1.0 | 10 | 12 | 3.1 | 2.3 |
| Education up to 12 yrs | 1.8 | 1.6 | 19 | 23 | 3.2 | 2.8 |
| University level, lower grade | 2.0 | 1.8 | 25 | 21 | 3.4 | 3.1 |
| University level, high grade | 1.9 | 1.7 | 26 | 21 | 3.6 | 3.2 |
| **Place of abode:** | | | | | | |
| Oslo/Akershus | 1.7 | 1.3 | 23 | 18 | 3.5 | 2.8 |
| Bergen, Trondheim, Stavanger | 1.5 | 1.4 | 14 | 17 | 3.2 | 3.0 |
| Towns 30-100.000 inhabitants | 1.4 | 1.5 | 16 | 23 | 2.9 | 2.7 |
| Smaller towns | 1.8 | 1.6 | 21 | 19 | 3.3 | 2.8 |
| Rest of the country | 1.7 | 1.5 | 21 | 21 | 3.3 | 2.5 |
| **Employment:** | | | | | | |
| Employed, >=40 hours per week | 2.3 | 2.0 | 30 | 29 | 3.6 | 3.0 |
| Employed, 30-40 hours per week | 1.9 | 1.9 | 26 | 28 | 3.4 | 3.2 |
| Employed, < 30 hours per week | 1.4 | 1.5 | 13 | 18 | 3.3 | 3.1 |
| Not employed | 0.8 | 0.8 | 6 | 15 | 3.0 | 2.1 |
| **Household income: (NOK 1000)** | | | | | | |
| < 100 | 0.9 | 0.4 | 7 | 2 | 3.2 | 1.8 |
| 100-199 | 1.4 | 1.1 | 16 | 5 | 3.2 | 2.8 |
| 200-299 | 1.4 | 1.7 | 14 | 22 | 2.9 | 3.1 |
| 300-399 | 1.8 | 1.8 | 25 | 27 | 3.2 | 3.0 |
| 400-499 | 2.0 | 2.1 | 23 | 31 | 3.4 | 3.2 |
| 500+ | 1.9 | 2.1 | 25 | 29 | 3.6 | 3.3 |
| **Total** | 1.6 | 1.4 | 20 | 19 | 3.3 | 2.7 |
| **Number of respondents** | 2771 | 4321 | 2771 | 4321 | 2771 | 4321 |

## 4.2 Private use of the home computer

The use of computers without an Internet connection for private tasks is perhaps the kind of use least to do with mobile communication, with travel. Some of it might substitute for leisure activities and travel, but there is no necessary

connection between the four types of private use recorded here and travel. This is better taken as an indication of how usual this kind of technology is in people's everyday lives. It tells about the tendencies of habituation of one type of technology.

On average, people without an Internet connection use the computer for writing documents, letters, etc., 1.8 times a week; they use it for numerical tasks 0.9 times, for graphics and illustrations once and for playing games 3 times per week. "Other tasks" are carried out 2.4 times per week. All these tasks are highly significant correlated with each other (0.01 level (2-tailed)). To simplify the analyses we have therefore constructed an additive index of these four variables.

Connection to the Internet makes a great difference for the home computer's area of application also related to private tasks. For respondents who have an Internet connection the substitutionary aspect of telecommunication for travel is more direct than for those without this connection for both private and work tasks.

Private tasks for those with an Internet connection are in addition to those mentioned above, sending/receiving e-mail to/from friends, relatives or others, searching for information, news, etc., ordering goods or services, sending/receiving documents, and other tasks. Some of these tasks can be substituted by travel; for example, ordering goods instead of shopping, ordering tickets directly on the Internet from an airline instead of visiting a travel bureau. But ordinary mail and use of the telephone are alternatives to both travel and use of the Internet for many of these tasks. However, some of them would probably not have been done had access to the Internet not been possible.

On average, people with an Internet connection send/receive mail from friends and relatives 2.4 times per week; they send/receive mail from others and attend discussion groups 1.8 times per week, they search for information and news 3.3 times per week, order goods and services 0.1 time per week, send/receive documents 1.0 and carry out other tasks 1.5 times per week.

Information-seeking therefore represents 33 per cent of these tasks and sending/receiving mail more than 40 per cent, so the substitutionary potential of telecommunication for travel is small for these categories of private tasks.

As for the private purposes without an Internet connection category, we also have established an additive index on the basis of these tasks. The results for both indexes, categorised as private tasks1 and private tasks2, are given in Table 4.2.

*Table 4.2 Average use of the computer without and with Internet-connection at home for private tasks1 (the sum of writing documents, letters etc, numerical tasks, graphics and illustrations, games and other tasks) and with Internet-connection at home for private tasks 2 (the sum of sending/receiving E-mail, attending discussion groups, search for information and news, ordering goods/services, sending/receiving documents and other tasks). Numbers per week*

| | Without Internet connection | | | With Internet connection | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables | Private tasks 1 Times per week | Number of respon-dents | Sig. (F-test) | Private tasks 1 Times per week | Number of respon-dents | Sig. (F-test) | Private tasks 2 Times per week | Number of respon-dents | Sig. (F-test) |
| **Gender:** | | | ,003 | | | ,000 | | | .000 |
| Male | 5.8 | 727 | | 11.0 | 743 | | 10.3 | 668 | |
| Female | 4.4 | 675 | | 7.0 | 513 | | 5.5 | 456 | |
| **Age:** | | | .000 | | | .000 | | | .001 |
| 13-17 yrs | 8.3 | 131 | | 15.8 | 138 | | 11.0 | 115 | |
| 18-24 yrs | 5.8 | 132 | | 10.9 | 103 | | 11.4 | 96 | |
| 25-34 yrs | 4.0 | 293 | | 9.4 | 329 | | 10.2 | 305 | |
| 35-44 yrs | 4.7 | 377 | | 7.1 | 347 | | 6.6 | 312 | |
| 45-54 yrs | 4.9 | 285 | | 8.8 | 248 | | 7.3 | 218 | |
| 55-66 yrs | 5.3 | 139 | | 7.5 | 72 | | 4.5 | 62 | |
| 67 + yrs | 5.6 | 45 | | 7.8 | 19 | | 4.5 | 16 | |
| **Education:** | | | .000 | | | .000 | | | .260 |
| Compulsory school (9years) | 7.0 | 208 | | 12.7 | 207 | | 9.8 | 168 | |
| Education up to 12 yrs | 5.5 | 552 | | 9.7 | 436 | | 8.9 | 398 | |
| University level. lower grade | 4.3 | 291 | | 7.6 | 217 | | 6.9 | 200 | |
| University level. high grade | 3.8 | 327 | | 7.9 | 376 | | 7.8 | 343 | |
| **Employment:** | | | .000 | | | .001 | | | .964 |
| Employed. >=40 hours per week | 5.2 | 196 | | 8.5 | 267 | | 8.8 | 242 | |
| Employed. 30-40 hours per week | 4.2 | 692 | | 8.3 | 570 | | 8.2 | 516 | |
| Employed. < 30 hours per week | 5.4 | 208 | | 10.5 | 180 | | 8.6 | 158 | |
| Not employed | 7.0 | 305 | | 12.0 | 236 | | 8.2 | 205 | |
| **Total** | 5.1 | 1401 | | 9.3 | 1253 | | 8.4 | 1121 | |

Men use the computer for private purposes more than women do, and young people more than the elderly. For tasks carried out without an Internet connection there is also a significant difference between educational groups and after employment. Those with low education and not gainfully employed use the home computer more for writing documents, correspondence, playing games etc (private tasks1) than those with high education and within the work force. Education and employment are strongly related to age, and this is the main explanation behind the frequent use among these groups. Young men are the most frequent users of the computer for these purposes, and playing games is the most decisive activity. The differences between men and women are most distinct among the youngest (13–17 years). Boys have a weekly use frequency of 16.1; girls of 6.5. In the age group 18–24 years, the frequency of use for boys is 10.4 and 5.1 for girls. Among other age groups there are no significant differences

between the genders. These differences between young men and women have also been found in other studies (Telenor 1999).

Use of the home computer for private purposes, either with or without an Internet connection, bears little relation to mobility. Some of these activities can be considered analogous to trips related to various leisure activities and shopping. The correlation[2] analysis, however, shows no significant negative relations between this type of use of the home computer and travelling, as we would have expected if stationary communication was substituted for travelling (Table 4.3).

*Table 4.3 Correlation between index – use of home computer without and with Internet-connection for private purposes1 and 2 (see table 4.2) – and travel. Pearsons r . N=1253 with Internet connection. N=1124 without Internet connection*

| | Trips related to visits | Trips related to leisure | Trips related to shopping | Trips per day in total | Trips as a car driver | Km as a car driver per day |
|---|---|---|---|---|---|---|
| Index – use of computer without Internet-connection at home for private purposes 1 | .020 | .002 | .016 | .025 | .006 | -.026 |
| Index – use of computer with Internet-connection at home for private purposes 1 | .062* | .006 | -.045 | -.009 | -.047 | -.020 |
| Index – use of computer with Internet-connection at home for private purposes 2 | .051 | -.042 | -.042 | -.016 | -.027 | .008 |

* Correlation is significant at the 0.05 level (2-tailed)

The activities (especially playing games) are additional to other leisure activities. The correlation analysis shows that there is no relation between car-use, measured as trips as a driver and distance in kilometres per day, and use of the computer for private purposes (without an Internet connection). The correlation analysis between use of the computer for private tasks, the number of trips related to leisure and number of trips in total per day is not significant either. However, there is a positive relation between use of the computer for these purposes and number of trips related to private visits of friends and relatives for those who have an Internet connection. High frequency on one activity is correlated with high activity on the other. Use of stationary technology for private purposes is either additional to travelling or it is not related at all.

[2] The correlation analyses can only be taken as indications because of the differences in periodes for travel activities and use of the home computer (see section 3).

## 4.3 Use of the home computer for paid work

The most relevant tasks related to substitution of travel are to work at home instead of travelling to place of work. As discussed in the Introduction to this paper, there is considerable interest in the possible reduction of work trips as a means of reducing the environmental problems related to car traffic, and especially during the rush hours.

To use information technology at home for work purposes can be seen as a potential for substitution of mobile communication also for those without an Internet connection. The mediation of information (and texts) between work and home can be done by diskette. In this sample, the frequency of different work-related tasks per week is 1.4 for writing documents, letters, etc, 0.8 for numeric calculation, 0.3 for graphic work and illustrations and 0.8 for other tasks, i.e. three times per week. Use of the computer related to paid work is, as we can see, less frequent than private use when there is no Internet connection.

*Table 4.4 Average use of computer without Internet-connection at home for paid work 1 (the sum of writing documents, letters etc, numerical tasks, graphics and illustrations, and other tasks) and with Inter net-connection at home for paid work 2 (the sum of sending/receiving E-mail, searching for information/news, ordering goods/service, sending/receiving documents, and other tasks). Times per week for respondent with paid work.*

| | Without net-connection | | | With net-connection | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables | Paid work 1 Times per week | Number of respon-dents | Sig. (F-test) | Paid work 1 Times per week | Number of respon-dents | Sig. (F-test) | Paid work 2 Times per week | Number of respon-dents | Sig. (F-test) |
| **Gender:** | | | .010 | | | .003 | | | .007 |
| Male | 2.3 | 561 | | 5.4 | 604 | | 5.2 | 508 | |
| Female | 1.5 | 494 | | 3.3 | 364 | | 2.5 | 303 | |
| **Education:** | | | .073 | | | .004 | | | .396 |
| Compulsory school (9years) | 1.3 | 104 | | 3.5 | 97 | | 4.5 | 73 | |
| Education up to 12 yrs | 1.5 | 419 | | 4.1 | 339 | | 3.6 | 279 | |
| University level. lower grad | 2.1 | 246 | | 4.7 | 189 | | 3.1 | 161 | |
| University level. high grade | 2.5 | 281 | | 5.4 | 341 | | 5.3 | 295 | |
| **Employment:** | | | .010 | | | .000 | | | .000 |
| Employed. >=40 hours per week | 2.9 | 195 | | 6.9 | 258 | | 6.7 | 217 | |
| Employed. 30-40 hours per week | 1.7 | 665 | | 3.6 | 545 | | 3.5 | 456 | |
| Employed. < 30 hours per week | 1.6 | 195 | | 4.1 | 165 | | 2.3 | 138 | |
| **Occupational status:** | | | .104 | | | .033 | | | .330 |
| Manual worker | 1.5 | 424 | | 3.4 | 344 | | 2.8 | 300 | |
| White collar worker | 1.8 | 323 | | 4.5 | 319 | | 4.7 | 258 | |
| Professional | 2.5 | 229 | | 5.7 | 235 | | 5.1 | 199 | |
| Owner | 3.0 | 65 | | 7.7 | 58 | | 6.4 | 43 | |
| **Total** | 1.9 | 1041 | | 4.6 | 956 | | 4.0 | 726 | |

The additional issues related to work tasks for those with an Internet connection were sending/receiving E-mail/attending discussion groups, searching for information/news, ordering goods/services related to work, sending/receiving documents, and other work tasks (paid work2). The weekly frequencies of these different tasks are 1.5 for E-mailing and discussion groups, 1.1 for information/news, 0.04 for ordering goods/services, 1.1 for sending/receiving documents, and 0.5 for other work-related tasks. On average, four times a week.

Just as for private use, we constructed additive indexes for use of the computer for paid work, both with and without an Internet connection. The most significant differences in application of the home computer for work purposes are found between men and women and between those with long weekly working hours and those with part-time work or those with "normal" working hours (Table 4.4). Men's use is about twice that of women's use, and people who work 40 hours or more per week also use it twice as much as people with shorter working hours. Men are in the majority when it comes to working long hours, so those characteristics reinforce each other. It seems that work at home for these men comes in addition to their regular work at the workplace. This supposition is reinforced when we consider the correlation analyses presented in Table 4.5.

*Table 4.5. Correlation between mobile (kilometres as a car driver per day. car trips per day and total trips per day) and stationary communication (index for use of computer without an Internet connection at home for work purposes1 and work purposes2). respondents in paid work. N=2023 (without a connection) N=811 with an Internet connection.*

| | Work trips | Busines s trips | Km as a driver per day | Trips as a driver per day | Total trips per day |
|---|---|---|---|---|---|
| Index – use of computer without Internet-connection at home for work purposes 1 | -.030 | .058 | .022 | .055 | .004 |
| Index – use of computer with Internet-connection at home for work purposes 1 | .082* | .103** | .092** | .119** | .081* |
| Index – use of computer with Internet-connection at home for work purposes 2 | .063 | .063 | .073* | 0.056 | 0.014 |

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

As the correlation[3] analysis shows, there is no substitution of mobile communication, travelling, by use of stationary communication devices. It is rather the opposite, especially for those who have an Internet connection in relation to work purposes1. People who use the computer at home in relation to their paid work have more car trips and total trips than people who do not use the computer for such tasks. Rather than being a substitute for mobile communication, stationary communication seems to be additional when the computer is used for tasks related to paid work.

[3] See footnote 2.

The correlation between the index for work purpose2 for those with an Internet connection and number of kilometres by car as a driver shows a positive significant relation. Those who use the home computer for work-related tasks also drive long distances (with themselves as driver). The correlation with the other measures of mobility shows neither a positive nor a negative relation.

A primary conclusion is that there is no substitution of travel by use of communication technology among those who own and use a home computer(s). It is rather the other way around. Most high frequency users of stationary communication technology are also frequent users of the car.

# 5 The possibility to work at home and the amount of travel activity

## 5.1 The possibility to work at home

In the questionnaire the respondents were asked if they had the possibility to work at home and, if so, how many times (whole days or part of a day) they had done so during the previous week.

Related to the discussion of substitution of travelling by use of stationary technology, type of work and place of abode are important policy variables in addition to those already discussed. Type of work is important related to development on the labour market. Which industries will expand and which will decrease, and in which of them will information technology be the most important? The information we have about the work of the respondents is limited to occupational status, which gives a division between manual and non-manual work and a rough categorisation of rank. The tendency in the labour market is towards less manual and more non-manual work, and the demand for qualifications (education) is increasing. In relation to place of abode, the urban–rural dimension, there are two interesting aspects concerning the substitution of travel. Rural areas or less urbanised and are attractive in terms of housing prices, and environmental qualities can be more suitable for living because place plays a less important role for where people can work. In urban areas, working at a distance can in the best case reduce car traffic in total and in the rush-time hours in particular.

Of the sample, 30 per cent say they *can* work at home. 6 per cent have their permanent workplace at home, which means that they work mostly at home, and 64 per cent cannot work at home (Table 5.1).

The most significant differences are related to occupational status, weekly working hours, income and education. People with non-manual work and high rank, high income and education and long weekly working hours have the greatest possibility to work at home. These highly mobile groups have very good access to cars and are frequent car-users.

There are also significant differences between men and women and between people living in different types of areas. It seems that inhabitants of the most urbanised areas have a greater possibility to work at home than people from less urbanised areas. Differences in the level of education and type of occupation might explain the differences we find in relation to place of abode.

*Table 5.1. Those with the possibility to work at home after gender, education, weekly working hours, occupation, income and place of abode. Per cent*

| Variables | Yes. can work at home | Yes. have permanent workplace at home | No. cannot work at home | Total | Number of respondents |
|---|---|---|---|---|---|
| **Gender: **** | | | | | |
| Male | 33 | 5 | 62 | 100 | 1145 |
| Female | 27 | 7 | 67 | 101 | 857 |
| **Education: ***** | | | | | |
| Compulsory school (9 yrs) | 26 | 6 | 68 | 100 | 178 |
| Education up to 12 yrs | 21 | 4 | 76 | 101 | 770 |
| University level. lower grade | 32 | 5 | 63 | 100 | 426 |
| University level. high grade | 42 | 10 | 49 | 101 | 621 |
| **Weekly working hours ***:** | | | | | |
| >=40 hours per week | 45 | 7 | 48 | 100 | 448 |
| 30-40 hours per week | 26 | 5 | 68 | 99 | 1240 |
| < 30 hours per week | 25 | 7 | 69 | 101 | 314 |
| **Occupational status:***** | | | | | |
| Manual worker | 20 | 2 | 78 | 100 | 748 |
| White collar worker | 32 | 6 | 63 | 101 | 649 |
| Professional | 42 | 8 | 50 | 100 | 465 |
| Owner | 42 | 27 | 31 | 100 | 116 |
| **Own income NOK 1000:***** | | | | | |
| Under 100 | 21 | 7 | 72 | 100 | 181 |
| 100-199 | 19 | 4 | 77 | 100 | 280 |
| 200-299 | 25 | 5 | 69 | 99 | 765 |
| 300-399 | 39 | 7 | 55 | 101 | 338 |
| 400-499 | 52 | 6 | 43 | 101 | 122 |
| 500+ | 46 | 12 | 42 | 100 | 123 |
| **Place of abode: ***** | | | | | |
| Oslo/Akershus | 35 | 7 | 59 | 101 | 712 |
| Bergen. Trondheim. Stavanger | 35 | 4 | 61 | 100 | 286 |
| Towns 30-100.000 inhabitants | 24 | 7 | 69 | 100 | 141 |
| Smaller towns | 24 | 7 | 69 | 100 | 339 |
| Rest of the country | 24 | 7 | 69 | 100 | 524 |
| **Total** | 30 | 6 | 64 | 100 | 2002 |

** Significant at the 0.01 level.
*** Significant at the 0.001 level.

As these analyses show, the potential for the substitution of journeys to work varies a great deal between social groups. Multivariate analyses of the possibilities to work at home are related mainly to occupational position and educational level. People with a high score on both variables have the most flexible spatial working situation. Gender and place of abode have less importance when controlled for the effects of these two variables.

The next question is how travel patterns are related to the possibility to work at home and the actual frequency of such work.

## 5.2 The frequency of "home work" and the travel patterns for groups with different access to a home computer

On average, employees who say that they can work at home actually stay at home 1.3 times a week (whole or part of the day). There are very few differences between the different groups mentioned above. There is a tendency for the owner of a business and part-time workers to have a slightly higher frequency than others, but the differences are not significant. (We have also analysed whether family situation has an impact on the tendency to work at home. but people with small children do not work more at home than other groups; rather. there is a tendency for people without family to work more at home than others). It seems that if people have the opportunity to work at home they take advantage of this possibility just the same. If we assume that an employee has two work trips a day. working at home 1.3 days a week will reduce work travel by about 25 per cent a week. The possibility to work at home can also modify the travel pattern as a whole. That is the theoretical point of departure, but what is the reality of today?

In Table 5.3 we have compared daily travel patterns of employed groups with an annual income of NOK 200.000 or higher (to get the groups more homogeneous) with different access to home computers and possibilities for working at home. (Not all trip purposes are presented in the table and so the total number of trips is higher than the sum of those presented in the table). The results indicate that variations in travel patterns are fairly small. There is no significant difference in the total number of kilometres driven by car per day, even if there is a tendency for people who work mostly at home to travel a little shorter by car as a driver. The same group has fewer work trips, but the total number of trips per day is the same as for the other groups with a home computer who do not work permanently at home, and even more than those without a home computer. This supports the hypothesis that a reduction in one type of journey or trip will be replaced by other kinds; for instance, work trips can be replaced by trips related to leisure or shopping. In this case we see that those who work at home have more chauffeuring trips than those without home computers, which could indicate that working at home might be an adjustment to a family situation with children.

*Table 5.3. Number of trips per day for different purposes (not all purposes are shown) for employed people with different access to a home computer and possibilities for work at home. Employed with own income NOK 200.000 or more per year. Numbers per day.*

| Different trips | Without home computers (1) | With home computer. cannot work at home (2) | With home computer. can work at home (3) | With home computer. have permanent work site at home (4) |
|---|---|---|---|---|
| Trips related to visits per day | 0.37(3.4) | 0.30 | 0.26 | 0.24 |
| Trips related to leisure per day | 0.46(3) | 0.45 | 0.60 | 0.55 |
| Trips related to shopping per day | 0.71 | 0.79 | 0.67 | 0.74 |
| Trips related to chauffeuring per day | 0.25(2.3.4) | 0.35 | 0.31 | 0.49 |
| Work trips per day | 1.03(4) | 0.91(4) | 0.97(4) | 0.68 |
| Business trips per day | 0.15 (3.4) | 0.13(3.4) | 0.27 | 0.19 |
| Number of trips per day | 3.26(4) | 3.45 | 3.60 | 3.87 |
| Number of trips as car driver per day | 2.07 | 2.10 | 2.22 | 1.95 |
| Km as a car driver per day | 29.2 km | 30.6 km | 28.8 km | 23.6 km |
| Total | 1454 | 820 | 444 | 84 |

(x) Significantly different from group x, $p < 0.05$.

The differences between group 1, those without a home computer, and the other groups are related mainly to the differences in socio-economic/demographic composition of these groups. People without a home computer are on average older; there are more women than men, and they have lower income and education (see Table 3.1).

# 6 Discussion

Considering the limitations related to the data sets, the results of our analyses show only to a very little extent any relation between ownership and use of a home computer and people's travel patterns. On the basis of these results we cannot see any substitutionary effects of the use of stationary technology at people's home on the use of mobile technology. Access to and use of information technology seems not to have a significant impact on travel activities in everyday life. Stationary communication seems to be a supplement to activities based on mobile technology.

For people who work more than "normal" weekly working hours, stationary technology seems to give them greater flexibility in regard to where to work, but it does not necessarily reduce their travel activity. The spatial flexibility will also give a temporal flexibility, which means that work trips and other trips can be more dispersed over the day than is the situation today. The positive consequence can be a reduction in the rush-hour traffic; the negative is that it is more difficult to offer a good public transport service when travel needs are more spread in time.

What these analyses also reveal is a strong relationship between the ownership of cars and the ownership of computers, and. as such, to a very high degree the same social groups who use the car and the computer. Men and high-income groups are more frequent users of the car than women and people with lower income. Men, high-income groups and people with high education more often own a home computer and have the possibility to work at home than people with low income and education. The possibility for flexibility related to the use of home computers and the new information and communication technology in general follow the existing divisions of different segments of the labour market. One crucial question is how the different segments will develop and their size. How many of the future workers of the labour stock will have the possibility to work at home, at neighbourhood centres, or to be mobile workers in general; how many want this type of flexibility and do companies want it?

If the possibility to flexibility regarding where and when to work continues to be a good for the privileged (high education/high income) in the future, it will be of great interest to know more about their preferences for living and also their daily activities in order to foresee the consequences for their travel patterns.

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