

**Internet Substitution For Transportation:
Evidence From A Survey In Rhode Island, USA**

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October 2002

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Abstract

This study is to identify factors that affect the use of or the intention to use Internet as a substitute for transportation. Data were collected from a sample of workers who live in Rhode Island, the United States. The findings indicate that work time flexibility, encouraging employers, educator as the occupation, having access to Internet at home, using computers longer than one hour a day, having more computers at home, and perceiving that using Internet can reduce time travel to work and shop are positively related to the use of or the intention to use Internet as a substitute for travel to work.

Key words: telecommunications, telecommuting, technology adoption, transportation, Internet

Internet has changed many things in the world, including work and life. The increasing popularity of telecommuting reflects one of the major impacts of Internet on people's work and life styles, which has implications for public policies and personal choices. Policy makers are concerned about the impact of telecommuting on transportation patterns.¹ Employers are concerned about the impact of telecommuting on productivity² and human resources.^{3,4} Workers are concerned about telecommuting's impact on family wellbeing.^{5,6} To understand these questions, the first step is to ask "What types of people are more likely to be telecommuters?"

The literature on telecommuting is increasing in recent years, but no study focuses on this question with the exception of a study by Mokhtarian and Salomon.⁷

The purpose of our study is to examine factors associated with workers who use or intend to use Internet to substitute for work-related travel. This study has identified several variables that are not reported in previous studies, such as occupation, length of using computer at home, work time flexibility, and perceptions of Internet impact on time use. The findings of this study will enrich the literature and increase our understanding on this important topic. In the following, we will first discuss hypotheses based on the literature. Then we will present the method, findings, discussion, and conclusion.

Hypotheses

While telecommuting is technically feasible in many communities, its practice is still limited. The preference of telecommuting may be affected by several sets of variables. Based on the literature, we have identified four sets of variables -- work environment, home environment, worker characteristics and perceptions of Internet impacts -- that may affect workers' telecommuting preference. Workers in work and home environments that encourage and facilitate telecommuting, with characteristics that are in favor of telecommuting and perceptions of positive Internet impacts, would be more likely to telecommute (see Figure 1 for a conceptual map). We will discuss these hypotheses in more details in the following sections.

Work Environment

A work environment that is favorable to telecommuting could include the job suitability, encouraging employers, and flexible work structures such as work time and days. Based on the literature, we have following hypotheses.

H1: Workers whose work time is more flexible are more likely to telecommute than those with less flexible work time.

H2: Workers who work fewer days per week are more likely to telecommute than those who work more days per week.

H3: Workers whose employers encourage telecommuting are more likely than others to telecommute.

H4: Professional and managerial occupations are more likely than clerical occupations to telecommute.

Hypotheses 1 and 2 are based on work flexibility. Flextime is broadly defined as the ability to rearrange one's work hours within certain guidelines offered by the company.⁶ Research indicates that employees with flextime are more satisfied with their jobs, more likely to want to remain on the job, and show more initiative than workers with no access to these policies.⁸ Perceived job flexibility is related to improved work-family balance.⁶ Flexible work time and days may be indicators of job flexibility of a company. Workers in this type of company may be more likely to telecommute.

Hypothesis 3 is self-explanatory. Many major American companies are encouraging telecommuting to enhance productivity, improve profit, and remain competitive.⁴ The extent of telecommuting permitted by the job has a positive effect on the telecommuting preference.⁷

Hypothesis 4 needs more explanations. Some occupations may be more amenable to telecommuting than others. A study conducted in California investigated perceived drives and

constraints of telecommuting by various occupations.⁹ The findings indicate that clerical workers are more likely than managers or professionals to see the family, personal, and office stress-reduction benefits of telecommuting as important; whereas managers and professionals are more likely to cite getting more work done (higher productivity) as the most important advantage of telecommuting. Constraints present more strongly for clerical workers than for other occupations include misunderstanding, supervisor unwillingness, job unsuitability, risk aversion, and perceived reduced social interaction. Constraints operating more strongly for professional workers include fear of household distractions, reduced social and professional interaction, the need for discipline, and lack of visibility to management. Key constraints present for managers include reduced professional interaction and potential for household distractions. These findings are difficult to integrate in the form of a hypothesis that predicts the preference of telecommuting among various occupations. However, occupational differences in telecommuting may come from job flexibility, such as flexible work time and days. For example, compared to clerical workers, the managerial and professional workers would have a higher level of job flexibility and could be more likely to telecommute.

Home Environment

The home environment has many dimensions including physical, economic, social, and technical. In this study, we focus on the technical aspect of home environment.

H5: Workers who have computer access at home are more likely to telecommute than those who do not.

H6: Workers who have more computers at home are more likely to telecommute than those who have fewer computers.

H7: Workers who have faster Internet connections at home are more likely to telecommute than those who have slower connections.

Previous research has focused on work-family conflicts when telecommuting is studied.⁶ No study to date has related home computer environment with the likelihood of telecommuting, but these variables may be important predictors of the telecommuting preference. Without helpful home computer environment, a worker cannot do the work well or at all at home. Internet access at home is a prerequisite for telecommuting workers. For workers who have a choice to telecommute, the existence of this condition would facilitate the decision to telecommute. Extra computers at home would have the potential to reduce work-family conflicts when other family members need computers for schoolwork or entertainment. Similarly, faster modem connections would allow telecommuters, current and potential, to mitigate the stress and frustration resulted from waiting and, in case of high-speed DSL or Cable Modems, avoid tying up a phone line.

Worker Characteristics

In this study, we focus on two worker characteristics that may affect their telecommuting preferences, gender and computer skill. Specifically,

H8: Females are more likely than males to telecommute.

H9: Workers who use computers more hours a day are more likely than those who use fewer hours to telecommute.

Hypothesis 8 is about gender difference. No study to date has documented gender difference in the telecommuting preference. However, there is gender difference when drives and constraints of telecommuting are examined. Women, on average, rate the advantages of telecommuting more highly than men. Women are more likely than men to have family, personal

benefits, and stress reduction as potential motivations for telecommuting, and more likely to possess the constraints of supervisor unwillingness, risk aversion, and concern about lack of visibility to management.⁹ Some scholars argue that women may be more likely to telecommute since they have multiple work and family roles compared to their male counterparts.⁷

Hypothesis 9 utilizes the length of using computer at home as a proxy for worker's computer skill. A typical telecommuter usually works at home one or two days a week. If a worker uses computers longer than other workers at home everyday, we consider that this person have greater computer skill and thus greater propensity to telecommute.

Perceptions of Internet Impact

Positive perceptions of telecommuting could help workers form telecommuting preferences. In this study, we focus on two perceptions, the perceived telecommuting effects on saving time for work-related and shopping-related travel. Specifically,

H10: Workers who perceive using Internet as saving travel time to work are more likely to telecommute than others.

H11: Workers who perceive using Internet as saving travel time to shop are more likely to telecommute than others.

Attitudinal variables play an important role for people who choose telecommuting. In a study of telecommuting preferences, researchers have used attitudinal variables to form various drives and constraints and these variables showed significant effects.⁷ In this study, attitude has been operationalized as perceptions of Internet's impact on time spent for travel to work and to shop. We regard saving time for work and shopping travel by using Internet as being beneficial

to workers. Thus, perceptions of such time savings should be positively related to the telecommuting preference.

Methods

Two surveys were conducted in South Kingstown, Rhode Island, the United States, in 2001. The first survey was conducted among local residents. A mailing list of 5000 names was obtained from the mailing list service of *Providence Journal-Bulletin*, the major newspaper in Rhode Island. A four-page questionnaire was mailed to the respondents in January 2001 and 925 questionnaires were returned with a response rate of 18.5%. In April 2001, the same questionnaire was sent to 2,600 University of Rhode Island employees. By May 2001, 780 usable questionnaires were returned with a response rate of 30%. In this study, the two samples were combined for the analyses.

The combined data set has 1,705 observations. In this paper, we focused on people who were employed outside home. Further, we excluded observations that have missing values in variables used for this study and those who said they were telecommuters at the survey time but reported that they did not have access to Internet and did not have computer at home. These adjustments resulted in a final sample size of 1,182 used in this study.

The focused variable in this study was “using or intending to use Internet to substitute for travel to work”. A behavioral change theory states that people's behavioral change is a multi-step process, such as precontemplation, contemplation, preparation, action, and maintenance.¹⁰ Therefore, a change occurs step by step. Based on this theory, these questions were used to collect information for this variable: (1) *Do you use Internet/World Wide Web to AVOID*

traveling to work now? (2) If NO, what are your intentions for the future? (3) If YES, how long have you been doing it?

Based on the information collected from the above questions, we divided the respondents into three groups: those who do not intend, those who intend to use, and those who currently use Internet to substitute for travel to work. We labeled the three groups as "no change," "intend to change," and "user," respectively.

The independent variables included number of work days per week, perceived work time flexibility (0-no flexibility, 9-complete flexibility), if the employer encourages telecommuting, occupation, if having access to Internet at home, number of computers at home, Internet connection method, gender, length of time using computer at home per day, perceived Internet impacts on travel time to work and to shop. The occupation variable has five categories: managerial/professional, office/clerical/sales, educator, technical/skilled, and other. Because the data were collected in an area where a university is located, educators mean people who work in a higher education setting. University educator can be considered as a special category of professional occupation in terms of job flexibility.

First, chi-square tests were used to test for associations between the dependent variable (Internet substitution for transportation) and independent variables. Next, multilevel logistic analysis was conducted, with the Internet substitution for travel variable as the dependent variable, to examine if independent variables continued to have effects when all independent variables are tested together.

Findings

Chi-square results

Table 1 reports results from the chi-square tests, which are all statistically significant ($p < .05$).

Work environment. Hypotheses 1 to 4 are supported. Clearly, the respondents who work four or few days are more likely to use or intend to use Internet as a substitute. For example, 12% of workers who work four or fewer days a week currently use Internet to avoid travel to work compared to only six percent of other workers who have to work five or more days a week do so. Workers who have a more flexible work schedule are more likely than those who have fixed or less flexible work schedule to use (13% vs. 5% and 2%) or intend to use Internet substitute (7% vs. 4% and 2%). Respondents whose employers encourage telecommuting are more likely to use (27% vs. 4%) or intend to use (7% vs. 4%) Internet as a substitute for travel. Managerial and professional occupations are more likely than office, clerical, and sales occupation to substitute Internet for travel (5% vs. 1%). Educators are most likely than those in other occupations to avoid travel by using Internet (17% vs. 1-5%).

Home environment. Hypotheses 5 to 7 are also supported by chi-square tests. The respondents who have access to Internet at home are more likely than those who do not use (8% vs. 0%) or intend (5% vs. 1%) to use the Internet substitute. The number of computers at home is positively related to the Internet as a substitute for travel. The respondents have two or more computers are more likely to use (14% vs. 4% and 0%) or intend to use (6% vs. 4% and 1%) the Internet to substitute for travel to work. Faster-speed Internet connection seems positively related to the Internet substitution behavior. Nine percent of respondents who have cable modems or other faster connections currently use Internet to avoid travel for work, compared to seven percent of respondents who only have dial-up modem connections.

Worker characteristics. Based on the chi-square tests, Hypothesis 8 is rejected but Hypothesis 9 is supported. Unlike predicted by Hypothesis 8, male respondents are more likely than female to use (8% vs. 5%) or intend to use (5% vs. 3%) Internet to avoid travel to work. The longer time the respondents use computer a day, the more likely they are to use (14% vs. 6% and 3%) or intend to use (8% vs. 5% and 2%) Internet for travel substitution.

Worker perceptions. The perceived impact of Internet use on reducing travel time seems positively related to Internet substitution for travel behavior. For examples, respondents are more likely to use Internet substitution for travel if they believe that Internet use results in less travel time to work (29% vs. 1-14%) and shop (13% vs. 3-7%).

Logistic results

Because the chi-square tests only investigate the possible association between two variables, we consider the findings preliminary. Multivariate analyses are needed to examine if the effects still exist when all the possible factors enter into one model. Because the dependent variable is a three-level categorical variable, the multilevel logistic model was used to test the effects of the independent variables. Adjustments were made for several variables. The following variables were used as continuous measured variables: workdays per week and work time flexibility. Each of the perceived Internet impact variables was coded as 1 if using less time perceived. A stepwise variable selection procedure was used in the logistic analysis.

Table 2 presents the logistic analysis results. Three work-related variables (work time flexibility, employer encouragement, educator as an occupation), three computer related variables (having access to Internet at home, number of computers at home, and using Internet longer than one hour a day), and two perception variables (perceived that Internet use reduces

time in work related activities and shopping) showed positive effects on the behavior of Internet substitution for travel. In other words, respondents who have more flexible work time, are encouraged by the employer to telecommute, are educators by occupation, have Internet access at home, have more numbers of computers at home, use Internet more than one hour a day, and perceive that Internet use can reduce travel time to work and shop are more likely to use or intend to use Internet to substitute for travel to work. Based on the findings of the logistic analysis, seven (Hypotheses 1, 3, 5, 6, 9,10, 11) out of eleven hypotheses are supported by the logistic analysis.

Results from Additional Logistic Analyses

To gain more insights, we conducted three additional binary logistic analyses. The first is to compare no-changers with intend-to-changers, the second is to compare no-changers with telecommuters, and the third is to compare intend-to-changers with telecommuters (Table 3). The results of the first model indicate that flexible work time, time using computer per day, and perceived time saving by using Internet to substitute for travel to shop are positively related to those who intend to use Internet to avoid travel to work. The factors in the second model that distinguish between no-changers and telecommuters are employer encouragement, number of computers at home, being an educator, and perceived time saving for travel to work by using Internet. The findings from the third model indicate that employer encouragement, being an educator, and Internet connection method are distinguishing factors between intend-to-changers and telecommuters. These findings are summarized in Table 4.

Conclusion and Discussion

Before conclusions are drawn, limitations of this study should be noted. First, this is a study that draws a sample from one geographical area in the U. S., which is not representative of the U.S. population. Second, this is only a cross-sectional survey. Panel data may provide better understanding of the targeted behavior change. However, because the topic is important and current and there is only one existing study focused on this topic, the findings of this study will contribute to the literature on this topic.

This study used data collected from a sample of workers in Rhode Island, the United States, to examine factors that lead to telecommuting preference. The multivariate analyses indicate that work time flexibility, employer encouragement, educator as the occupation, having access to Internet at home, using computers longer than one hour a day, having more computers at home, and perceiving that using Internet can reduce time travel to work and shop are positively related to using or intending to use Internet to substitute for travel to work.

The findings from the logistic analysis provide some guidelines for focusing on factors that can stimulate individuals to move along the change process. For instance, to move people who have no intentions to consider telecommuting, it would be beneficial to focus on their general use of the Internet that affects their perception of the Internet as time saving even if it is for uses such as shopping. To convert people who have positive intentions to actual use, encouragement by the employer and the speed of Internet connections are important contributors. These can be used to target the kinds of people who are more likely to telecommute (educators, those with multiple computers, etc.) as well as employers who are likely to encourage telecommuting.

One of the four variables hypothesized as possible influential variables but not statistically significant is gender. No previous study documented gender difference in the

telecommuting preference. In the only one study we located, gender did not show effects, but the authors argue that the gender difference is embedded in other attitudinal variables.⁷ The same researchers do find gender difference in perceived drives and constraints of telecommuting preferences.⁹ Based on their findings, we speculated that females are more likely than males to telecommute but our chi-square results showed an opposite finding and the result from the logistic analysis showed insignificance of this variable. More research could be conducted to clarify this issue in the future.

Acknowledgement

This project was supported by the U. S. Department of Transportation through the University of Rhode Island Transportation Center (URITC) grant number 536131. Data analysis was supported by the Research Institute for Telecommunications and Information Marketing (RITIM) at the University of Rhode Island.

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Figure 1 Conceptual map

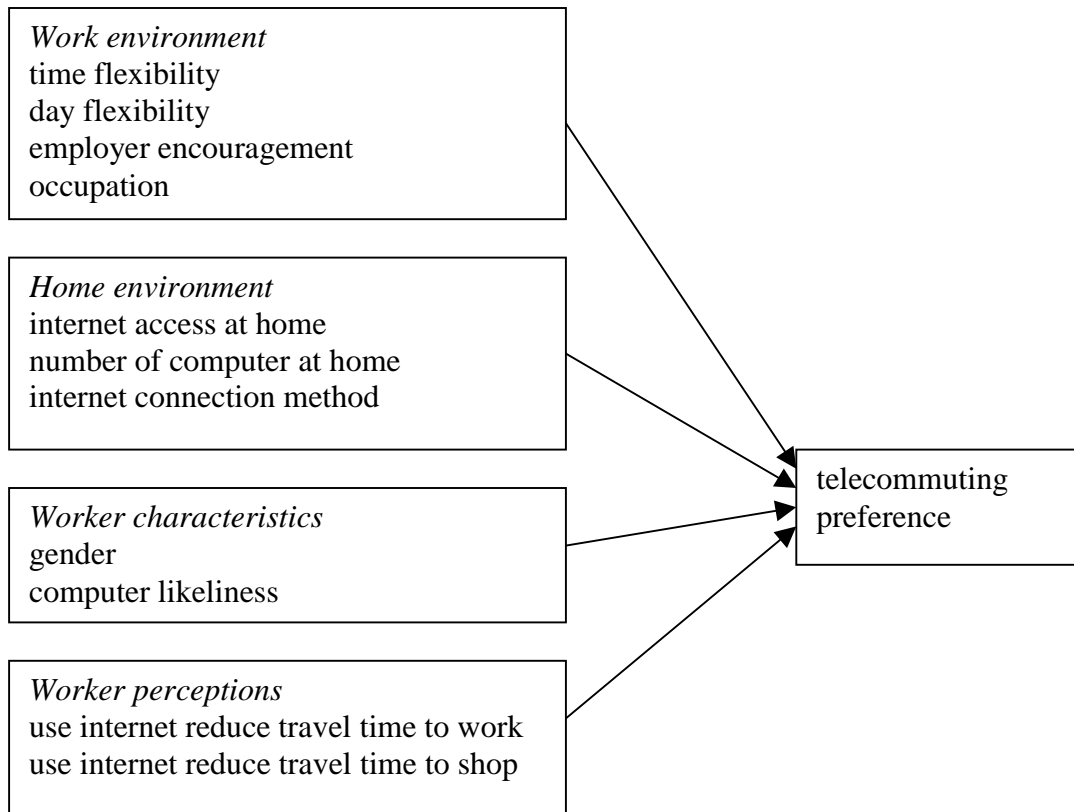


Table 1 Chi-square results

Variable	No change (%)	Intend to change (%)	User (%)	chi-square	p
<i>Workdays per week</i>				10.653	0.0308
4 or fewer days	82.61	5.59	11.8		
5 days	89.82	4.35	5.84		
6 or more days	91.84	2.04	6.12		
<i>Work time flexibility</i>				48.1178	<.0001
no flexibility	96.7	1.47	1.83		
less flexible	91.04	3.58	5.38		
more flexible	80.06	7.41	12.54		
<i>Telecommuting is encouraged</i>				18.508	<.0001
no	92.42	3.89	3.69		
yes	66.67	6.54	26.8		
<i>Occupation</i>				63.8873	<.0001
technical/skilled	90.32	5.65	4.03		
office/clerical/sales	96.65	2.87	0.48		
managerial/professional	90.58	4.04	5.38		
educator	78.52	5.28	16.2		
other	94.12	3.36	2.52		
<i>Access Internet from home</i>				24.0501	<.0001
no	98.56	1.44	0		
yes	87.06	4.83	8.11		
<i>Number of computer at home</i>				59.9391	<.0001
none	99.09	0.91	0		
one	92.69	3.65	3.65		
two or more	79.9	6.19	13.92		
<i>Internet connection method</i>				14.0955	0.007
none	96.4	3.6	0		
modem	88.36	4.9	6.74		
cable and other	88.24	2.35	9.41		
<i>Length of using computer daily</i>				69.73	<.0001
30 minutes or shorter	95.76	1.66	2.58		
31-60 minutes	89.29	5.19	5.52		
61 minutes or longer	77.95	7.55	14.5		
<i>Gender</i>				8.2069	0.0165
female	91.57	3.24	5.19		
male	86.37	5.31	8.32		
<i>Perceived impact on travel for work</i>				17.4603	<.0001
more time	71.43	14.29	14.29		
less time	64.29	7.14	28.57		
no change	91.55	3.52	4.93		
not applicable/report	95.26	4.21	0.53		
<i>Perceived impact on travel for shopping</i>				55.1564	<.0001
more time	85.71	7.14	7.14		
less time	77.81	8.94	13.25		
no change	93.17	2.32	4.51		
not applicable/report	92.22	4.44	3.33		

Table 2
 Logistic Results: Factors Associated with Willingness to Telecommute

Variable	Estimated Coefficient	p
Intercept	-5.8392	<.0001
Intercept2	-5.1367	<.0001
Work time flexibility	0.1069	0.0046
Telecommuting is encouraged by employer	1.4468	<.0001
Having access of Internet at home	1.7252	0.0061
Using computer less 30 minutes or less	-1.3114	<.0001
Using computer between 31 to 60 minutes	-0.7379	0.0033
Perceived less time for work because of Internet use	0.4627	0.029
Perceived less time for shopping because of Internet use	1.1538	<.0001
Number of computers at home	0.5886	0.0075
Occupation is educator	0.8313	0.0001
-2 Log Likelihood	987.145	
Max-rescaled R-Square	0.3161	
Percent Concordant	84.9	
N	1103	

Table 3 Results from Additional Logistic Analyses

	Intend to change (vs. No change)	User (vs. No change)	User (vs. Intend to change)
Work time flexibility	0.1672		
Telecommuting is encouraged by employer		1.8469	1.5378
Using computer less 30 minutes or less	-1.1665		
Perceived less time for work because of Internet use		1.6720	
Perceived less time for shopping because of Internet use	1.1508		
Number of computers at home		1.1141	
Occupation is educator		1.2726	1.5496
Cable connection			1.4273
-2 Log Likelihood	407	572	172
Max-rescaled R-Square	0.1377	0.3500	0.3027
Percent Concordant	76.4	83.8	69.8
N	1103	1132	129

Note: all findings reported here are statistically significant at 5% or better.

Table 4 : Significant Differences between Groups

	No Intention to Change	Current Telecommuters
Intend to Change	Flexible work time Computer Use time per day Perceived Time savings of using Internet	Employer encouragement Educators Speed of Internet connection
Current Telecommuters	Employer encouragement Number of computers at home Educator Perceived Time savings of using Internet	NA