A Study on the Usage of Computer and Communication Technologies for Telecommuting

Yash P. Gupta, Jahangir Karimi, and Toni M. Somers

***Abstract*—Today, with the increasing proliferation of telecommuting in firms, information technology managers are confronted with yet another challenge of what telecommuting technologies and services to offer and to whom these technologies and services should be offered. This study intends to identify the telecommuters' patterns of usage of computer and communication technologies based on their background, employment, residential, and occupation characteristics. Based on a sample of 375 responses, this study finds that all of these factors can help to explain the usage of computer and communications technologies. The implications of the findings for researchers and technology managers are discussed.**

***Index Terms*—Telecommuters' background, employment, residential, and occupational characteristics, telecommuting, usage of computer and communication technologies for telecommuting.**

I. Introduction

TELECOMMUTING has the capacity of redrawing the geographical and organizational boundaries of the traditional, centralized enterprise. It enhances individual autonomy, control, flexibility, convenience, and family togetherness, and it improves flexibility in work arrangements that, in turn, results in higher productivity [2], [8], [38], [52]. USWest Communications, for example, reported that the productivity of telecommuters increased, some by as much as 40%. Further, the company reported savings of $4000–$21 000 annually per telecommuter in terms of space, reduced absenteeism, and retention of workers who might otherwise have left the company [49].[1,2] A recent survey of *Fortune 1000* executives, released by General Services Administration, reported that 92% of the executives with telecommuting experiences said it produced some advantages for their companies. Fifty-eight percent cited increased productivity, 61% reduced absenteeism, 63% improved employee retention, 64% savings on office space costs, 63% reduced employee stress, and 79% improved employee morale [6]. AT&T's 35 000 telecommuters saved the company $80 million in real estate costs last year [6]. A three-year government-backed initiative aimed at studying the impact of telecommuting on corporate America suggests that 64% of *Fortune 1000* companies in the United States have implemented telecommuting programs, and 60% of the companies currently without such programs expect to institute one within the next three years [51].[3]

Today, an increasing number of firms are providing telecommuting opportunities to their employees. As stated recently by Johnson [34] "without a solid base of grounded theory developed from scholarly research, telecommuting programs will be implemented without a clear understanding of what works and what doesn't. The popular media creates falsely optimistic or gloomy scenarios of the success and failure of programs based on biassed anecdotal evidence without providing empirical evidence to draw a meaningful conclusion."[4] This research is a step toward providing empirical evidence on the patterns of usage of computer and communication technologies for telecommuting.

There are a variety of computer and communication technologies that support telecommuting, such as telephones, computer modems, fax machines, electronic mail, and computer information networks. For technology managers and providers, there are a number of pressing issues, such as what services and technology to offer and where, when, to whom, and what is the best way to promote it. With the changing marketplace and escalating availability of advanced technologies, in addition to increasing user demands, this task is immense. Concomitantly, the characteristics and needs of telecommuters are evolving due to the changing regulatory and work environments and the growing use of technology. This evolution has also led to a different set of technology needs at the person's residence than is traditionally required by the residential market.

The purpose of this study is to clarify the telecommuters' patterns of usage of computer and communication technologies for

Manuscript received August 11, 1997; revised August 3, 1998. Review of this manuscript was arranged by Department Editor E. Geisler.

Y. P. Gupta is with the School of Business Administration, University of Washington, Seattle, WA 98195 USA.

J. Karimi is with the College of Business and Administration, University of Colorado at Denver, Denver, CO 80217-3364 USA.

T. M. Somers is with Wayne State University, School of Business Administration, Detroit, MI 48202 USA.

Publisher Item Identifier S 0018-9391(00)00601-2.

[1]According to a survey of 1000 large companies conducted by Forester Research, Cambridge, MA [21], every telecommuter costs their employer an average of $4000 to set up and more than $2000 a year to maintain. The money is spent for new computers and software, high-speed modems, hefty phone bills, and technical support back at corporate headquarters.

[2]The director of marketing for AT&T Virtual Office Solutions says "for every dollar spent, we saved $2" on their telecommuting project. With approximately 8000 employees functioning in the virtual world, managers report productivity up 45% and office space savings up 50% [62].

[3]Globally, the proliferations of telecommuting, however, have been mixed. In the United Kingdom it was projected that between 10-15% of the skilled workforce would be engaged in telecommuting by 1995, increasing 15–20% by the year 2010 [53]. On the other hand, in France it is predicted that telecommuting will not develop substantially even by the year 2005 [45]. An exposition of developments related to telecommuting in The Netherlands, Japan, the United Kingdom, Finland, Germany, and Australia is provided in [27], [31], [36], [39], [69], and [84], respectively.

[4]Further, as stated by Johnson [34] "organizations need to be cognizant of the infrastructure support needed to successfully implement telecommuting programs: human resources policies on employee selection, manager training, information systems hardware/software/telecommunications network support. . . ."

telecommuting and to provide a starting point in determining the factors that may influence the future of telecommuting industry. Specifically, this study intends to identify whether usage of computer and communication technologies vary based on telecommuters': 1) background; 2) employment; 3) residential; and 4) occupational characteristics. Based on a sample of 375 responses, this study finds that all of these factors can help to explain the usage of computer and communication technologies by telecommuters.

II. Background

Literature on telecommuting has suggested that telecommuters are computer-based information workers, and telecommuting is most often expected to be all-or-nothing, that is full-time work from home [27], [63]. Mokhtarian [50] argued that these are not the necessary conditions for telecommuting to occur. Martino and Wirth [47] stressed the need for a common definition of telecommuting and contended that there are at least 50 definitions of telecommuting in the literature.

Telecommuting is defined here as work carried out at home or at an office close to home (remote from central offices or production facilities) where the worker has no personal contact with co-workers but is able to communicate with them and perform work-related tasks using computer and communication technologies. This definition intends to include daytime home-based telecommuters, part-time workers, full-time workers, and the casual after-hours workers who work in an office or at home during regular hours or after normal hours.

Data on current levels of telecommuting are typically based on small and often nonrepresentative samples, and a lack of consensus on how telecommuting is defined can lead to widely disparate estimates and forecasts. The 1993 U.S. Department of Transportation (DOT), however, forecasts that 5.2%–10.4% of the labor force would be telecommuting in 2002—a 100% difference between the low forecast and the high forecast [76]. Currently, workers who telecommute do so on an average of one to two days per week, a part-time basis; the U.S. DOT report forecasts an increase to three to four days per week approaching a full-time basis. Together the numbers produce forecasts ranging from 1.0% (if telecommuting continues on a part-time basis) to 8.3% of workers telecommuting on a given day in 2002—a wide range for a relatively short-term forecast. By the year 2000 it is estimated that 25 million employees will telecommute [3], and by 2030 there will be over 90 million telecommuters in the United States alone [82].[5]

Literature has dealt with various aspects of telecommuting, such as managers and employees' attitude toward telecommuting[6] [14], [17], [37]; impact on job satisfaction and productivity of telecommuters [16],[7] impact on commute travel [15], [28], [41], [59]; impact on residential relocation [54], [55]; work and family tradeoffs for telecommuters [5], [18], [42], [78]; quality of working life [65]; mode of transportation [50]; energy and air quality [7]; legal and public policy issues [18], [35], [47]; and organizational, behavioral, and social issues [57], [58], [61], [74]. Despite the growing opportunities for telecommuting, however, very little is known about the patterns of usage of computer and communication technologies by telecommuters and the factors that can help to explain them. Usage of information technologies has been identified as the primary factor that affects white collar performance [73].

A. Usage of Computer and Communication Technologies for Telecommuting

The kinds of tasks that are ideal for telecommuting tend to be individually driven, require minimal instructions and checking, need not be performed at set times, and produce measurable results. While some jobs are clearly not candidates for telecommuting, e.g., jobs that demand a physical presence, such as waiters and hairdressers, many jobs involve at least some tasks that, barring other constraints, could be performed at home rather than at the usual work site [26]. In other words, jobs are not simply one or the other but fall along a spectrum, from not at all, to partially, to full telecommutable, with most jobs falling somewhere between the extremes.

Much of the work that telecommuters do at home does not require equipment beyond what is used to keep in touch with the office. Reading, thinking, and paperwork are often cited as tasks that telecommuters take home. But workers are increasingly using computers in the office. This suggests that many workers will not be able to telecommute without a computer at home, and that improvements in communication technologies will expand the set of work tasks that can be done at home.

The increased availability of computer and communication technologies also creates more incentive for the employers to provide opportunities for employees to telecommute. This opportunity, in turn, depends on the nature of the job, the state of technology, and the willingness of employers. Given the opportunity to telecommute, workers in turn will choose to telecommute depending on their characteristics and concerns. Workers' characteristics have impact on whether they decides to telecommute. Further, the nature of job, employment characteristics, and availability of computer and communication technologies are important factors for employers to provide telecommuting opportunities to their employees.

Previous studies on determinants of microcomputer usage have acknowledged the impact of the external factors such as

[5]Another study has suggested that by the end of the year 1995, 9.2 million Americans will have been working from home or telework centers; in the next 15 years, the number of telecommuters is expected to triple, representing 20% of the total U.S. workforce [83].

[6]A recent conference board survey of 155 companies shows that while more than 70% offered telecommuting options to their employees, fewer than 1% took part, citing mistrust by managers that telecommuters could be as productive while unsupervised. However, recently it was suggested that gone are the days when telecommuting was a privilege a boss granted an employee in a bind. Now companies, eager to slash costs, are the ones urging employees to telecommute [44].

[7]There are obstacles to productivity improvement via telecommuting such as missing out on office communications, difficulty in getting the boss's attention, and incompatible equipment. According to *The Wall Street Journal* [81], recently American Express's Hearth Program has addressed some of these concerns by pairing telecommuters with in-office "buddies" who are responsible for passing on news, fixing problems, and representing the duo in the workplace. In turn, the telecommuters can cover for their buddies by taking over a larger share of data processing or fielding calls if the in-office worker has to leave early. Although telecommuting has been touted as a means of increasing productivity and lowering overhead costs, one expert warns that remote work may lead to a "virtual dead end" of employee isolation and bureaucratic ineffectiveness. Another expert adds that telecommuting will not truly take off until desktop full-motion videoconferencing falls below U.S. $500 and ISDN is readily available [83].

individual, system, and organizational characteristics on system usage [12], [14]. Two models have been used to explain the factors affecting the user acceptance of computer technology: theory of reasoned action [20] and the technology acceptance model [12]. Both models have suggested external factors, such as individual, system, and organizational characteristics will affect behavior (i.e., usage) through their effects on beliefs.[8] The theory of reasoned action and its development by Mathieson [48] suggests that behavior is affected by attitudes toward use, subjective norms, and perceived behavioral control variables (such as skills, opportunities, and resources needed to use the system).

In addition, earlier research on the usage of communication technologies suggests that individuals select the communications channel with required level of richness to accomplish a particular communication task [11].[9] Further, the social presence theory suggests that media are chosen for specific types of interaction and for how well media "fit" communication task information requirements [67]. Media differ in social presence or "degree to which some medium permits user to experience others as being psychologically present" [23].[10] The social influence theory [8], [23], [64], however, suggests a socially defined, collective behavior of media use rather than the logical choice of an individual (based on the rational matching between the media characteristics and the nature of communication tasks). According to the social influence theory, social influences, such as the attitude of co-workers and management (or supervisors), organizational or group norms, and the interaction patterns at work, play a more critical role in shaping patterns of media use for an individual. The perceived richness, therefore, is defined not by the generic characteristics of a medium, but by its users. This is evident by the fact that although fax and e-mail are used extensively among businesses [24], [43], they are perceived differently and are not used interchangeably. A recent survey of 273 small businesses conducted by the Executive Committee of *Inc.* magazine found that while 56% use e-mail within the company for employee-to-employee communication, fewer than one in four use the Internet to contact clients, prospects, or business advisers. "Our industry just hasn't accepted e-mail yet as a regular form of communication. We do a lot of faxing via modem, but no e-mail," says one electrical contractor [31]. Therefore, this may suggest that external factors, such as socially defined collective behavior of media use, may have more impact on the communication media usage than logical choice of the user depending on the task.

In summary, based on the above discussion, there are reasons to believe that: 1) individual characteristics tend to impact individual behavior and an individual's decision to telecommute; 2) individual characteristics tend to be an important factor in selecting the kind of tasks that will be chosen for telecommuting; 3) the employment and occupational characteristics tend to be important factors for an employers' willingness to provide opportunity for employees to telecommute; and 4) socially defined collective behavior and an individual behavior play a critical role on media usage. However, there is no research, to our knowledge, that has investigated the differences that may exist in external factors, such as telecommuters' background, residential, occupational, and employment characteristics on computer and communication technologies usage. Due to proliferations of telecommuting in today's information economy, the changing work environment, and growing use of communication technologies, it is important to investigate whether the telecommuters' background, employment, residential, and occupational characteristics can help to explain their usage of computer and communications technologies for telecommuting. Fig. 1 illustrates this model.

III. Research Propositions

Beside descriptive surveys, very little is known about telecommuters' usage of computer and communication technologies and if the telecommuters' usage patterns can be explained based on their employment, background characteristics, occupational characteristics, and residential classification. It is reasonable to suggest that usage of computer and communication technologies would differ based on all of the above factors (see Fig. 1). For example, a latest survey of Internet access by American adults found that: 1) 3.7% are online; 2) 67% are men who make between $25 000 and $75 000 a year; 3) more than half of American adults users of the Internet were between ages of 18–34 and 25% were in the 35–44 age bracket; 4) 5.8 million had direct access to global computer network; and 5) 3.9 million subscribed to commercial online services, such as America Online, CompuServe, and Prodigy [32]. Therefore, this leads us to our first set of research hypotheses.

P1a) There is a significant difference in present usage of computer and communication technologies at home and outside home by telecommuters' background characteristics.

P1b) There is a significant differences in planned usage of computer and communication technologies at home and out side home by telecommuters' background characteristics.

Both business and nonbusiness owners can be telecommuters. A business owner is a telecommuter if he or she works remotely from central offices or production facilities located either in

[8]Both perceived ease of use and perceived usefulness have been shown to be significantly correlated with self-reported frequency of systems usage [1], [12], [20].

[9]Richness in a medium depends on a number of factors including the interactive nature of feedback, channel type, and personal quality of the source. Face-to-face and telephone communications are information-rich channels because they can convey a wide variety of social cues to the listener [70]. Electronic media, such as e-mail, fax, and mail services are not considered rich channels because they are limited to verbatim information. In addition, uncertainty and ambiguity have been identified as principle factors in predicting media usage. Individuals are expected to match the task information requirements that depend on its uncertainty and its ambiguity to the information richness of the media. This suggests that telephone communication is more appropriate for a task with high uncertainty and ambiguity (such as conflict resolution), and electronic mail is more appropriate for tasks with low uncertainty and ambiguity (such as simple information exchange).

[10]Media like face-to-face meetings and telephone have been found to be high in social presence, whereas media like e-mail and fax have been found to be relatively low in social presence [23]. For interpersonally involving and sensitive tasks, e.g., conflict resolution, media with high social presence, like the telephone, are selected, however for a less sensitive task, e.g., information exchange, the social presence of the medium is not as important as its efficiency [60], [66], [71]. For efficiency purposes only, e-mail or fax should be used. Beside ease of use and task characteristics, an external factor such as culture is also shown to play an important role in predisposition toward and selection of electronic communication media [72].

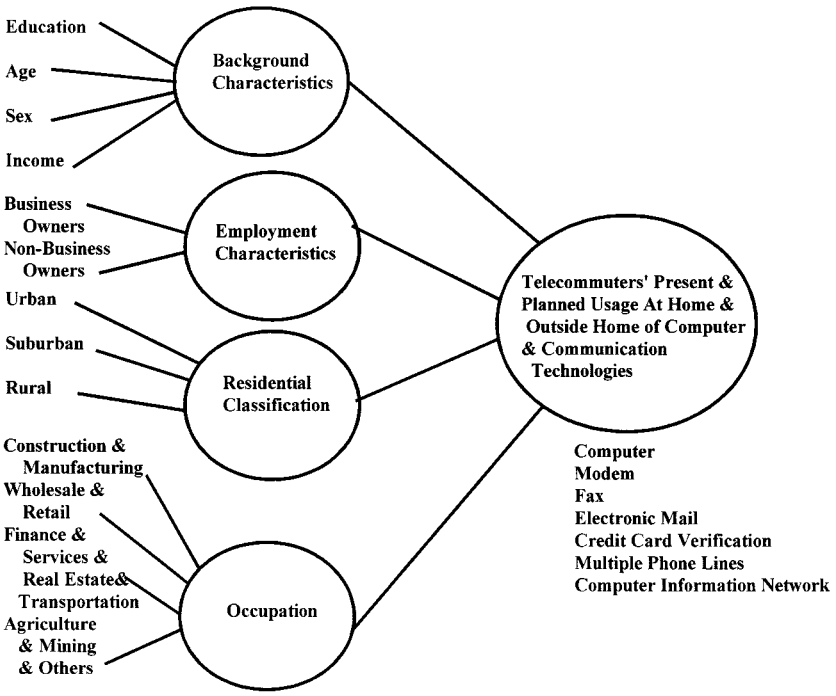

Fig. 1. A model of computer and communication technologies' usage by telecommuters.

an urban, suburban, or rural area. A nonbusiness owner is a telecommuter if he or she works remotely from central offices or production facilities located either in an urban, suburban, or rural area, e.g., a university faculty member working for a university from his or her place of residence. The difference, however, is that one owns the business for which he or she works and the other does not. Telecommuters' employment characteristics can provide insights into the frequency of usage of technologies. A recent report suggests business-oriented e-mail services, such as AT&T Mail, MCI Mail, and Sprint Mail, without the bells and whistles of commercial online services, could grow as much as 20% this year. Such services offer better security than the Internet and more reliability than commercial online-consumer services [80]. Furthermore, a Gallup poll of *Fortune 500* companies found that fax charges account for 40% of the average company's $34 million phone bill in 1994, with each corporate location now reporting about 27 fax machines, up from 19 last year. Similarly, the National Association of Purchasing Management reports that 75% of its members use fax machines more frequently than e-mail when purchasing goods [79]. Therefore, this leads to our second set of research hypotheses.

P2a) There is a significant difference in present usage of computer and communication technologies at home and outside home by telecommuters' employment characteristics.

P2b) There is a significant differences in planned usage of computer and communication technologies at home and outside home by telecommuters' employment characteristics.

The place of main residence is expected to play a major role in technology usage. Geographically dispersed telecommuters may use certain technologies more. Business owners are more likely to use computer and communication technologies at their homes than nonbusiness owners, and their frequency of usage in turn might also be greater. Therefore, it is plausible to expect differences in technology usage based on the residential classification. These expectations leads us to third set of research hypotheses.

P3a) There is a significant difference in present usage of computer and communication technologies at home and outside home by telecommuters' place of main residence.

P3b) There is a significant difference in planned usage of computer and communication technologies at home and outside home by telecommuters' place of main residence.

The U.S. Bureau of Labor Statistics estimates that approximately 30% of the U.S. workforce spends an average of 6–8 h per week telecommuting. In information-intensive industries such as insurance, banking, and transportation, however, this average ranges from 30 to 40 h per week [68]. Approximately 20 million nonfarm employees were engaged in some work at home as part of their primary job in May 1991, representing 18.3% of those at work. More than 60% of those who worked at home were simply "taking some work home from the office" and were not paid specifically for that. Of those who were paid, or were self-employed, only about half worked at home for 8 h or more per week [13]. The projected total number (in millions) and percentage of people in several key occupational categories who spend 20% or more of their time away from their desk or immediate work areas are 27.3 (74%); the distribution in the categories are: technical professionals 7.1 (75%); nontechnical professionals 14.4 (74%); owners 2.4 (75%); and managers 3.4 (72%) [77].

Information workers are more likely to have tasks that could be performed away from the office. Currently, information workers are generally estimated as being 50% or more of the labor force. A latest survey of Internet access by American

adults found that the most common jobs listed for those who had access to online world was sales at 19%, followed by engineering at 15%. The next three job functions, 29% total, were information managers, administration, and research and development [32]. Therefore, it is expected that usage of computer and communication technologies varies significantly based on telecommuters' occupation characteristics. This leads us to our forth set of research hypotheses.

P4a) There is a significant difference in present usage of computer and communication technologies at home and outside home based on the telecommuters' occupation.

P4b) There is a significant difference in planned usage of computer and communication technologies at home and outside home based on the telecommuters' occupation.

IV. Research Methodology

In this section we will discuss: 1) the design of the survey instrument; 2) survey population and sample selection; and 3) data analysis and the results.

A. Designing the Instrument

The telecommuting market primarily consists of three categories: those who are self-employed, those who are employees of a firm and work from their homes, and those who take work home. To accomplish the objectives of the study, analyses were performed on many levels. Focus groups were used as the primary sources of information for designing the survey instrument. They were used to gather qualitative data and to better understand the market for the new computer and communications technologies and its issues. Therefore, the selection of the participants for these focus groups was extremely important.

There were three focus groups. The first two consisted of representatives of a major regional phone company, and the third was primarily comprised of persons who owned small businesses, some of whom ran it from their home. The representatives of a major regional phone company were chosen for the first two focus groups because: 1) we thought they were the best sources of information regarding what present customers desire and 2) we wanted to overcome the myopic view that our participants might have had about innovation [4]. Bennett and Cooper [4] suggested that consumers verbalize their wants and needs, but they tend to talk in terms of the familiar, i.e., what is around them at a particular moment. Managers, therefore, learn only about the familiar needs of consumers expressed in consumers' own terms for a particular point in time. The consumers' views are limited in three ways: 1) consumers' perceptions of their needs are restricted to the familiar, to items consumers to which can relate, and a true innovation is very often out of the scope of the normal experience of the consumer; 2) consumers' ability to express these needs, to verbalize what they want, particularly when they do not know what is technologically feasible is limited; and 3) because of the dynamic nature of these expressed needs, they may well have changed by the time the new product is designed, tested, and manufactured.

By working with the focus groups we tried to gain as much information as possible regarding potential customer perceptions of the advantages and disadvantages of having the new communications technologies infrastructure. The focus groups were asked to add, delete, or combine communications technologies from a list of representative technologies as they deemed necessary to arrive at a set of representative technologies. A set of seven technologies was used in the final questionnaire. These were computer, modem, fax machine, electronic mail, credit card verification machine, multiple telephone lines, and computer information network (e.g., Prodigy, CompuServe). Details about each focus group are discussed elsewhere [25].

B. Survey Population and Sample Selection

The questionnaire contained several questions regarding telecommuters': 1) background characteristics; 2) employment characteristics; 3) residential classification; 4) occupation characteristics; and 5) present, planned, and hours-per-week usage of seven technologies at home and outside the home. Respondents were asked to choose the appropriate category response that best described their characteristics. Further, the telecommuters' technologies usage was measured by a five-point scale (1 = never, 5 = always). The hours-per-week usage was provided by the telecommuters.

For sample selection, the databases of a regional phone company were separated into two: residential customers and business customers. Each database was separately randomized. The two populations from which the samples were selected were residential and business customers with one or two lines in the U.S. southern states. The residential database contained 706 481 records and the business database 55 006 records. Two samples of 1500 records were selected from each database separately. The respondents consist of 152 business owners and 172 nonbusiness owners.

In Table I, we present descriptive statistics for the hours-per-week business activities performed from home based on telecommuters' background, employment, residence, and occupation characteristics. The number of hours-per-week usage was an approximation reported by telecommuters. The number of hours per week spent on business activities contained a good deal of variability. This is evidenced by an examination of the median values, which indicates that over half the telecommuters typically spend anywhere from 2 to 6 h per week on business activities at home. On the other hand, if we examine the means, we see that they range from an average of 5.8–14.7 h per week. Moreover, the standard deviations are quite large as well. Nonetheless, if we rank order our telecommuters in terms of who spends the most time per week on business activities from home, we find some interesting results. It would appear that business owners spend the most time, typically 14.7 h per week, and nonbusiness owners spend the least amount of time (typically 5.8 h). In fact, they spend significantly more time ($t = 5.32$, $p = .000$) than nonbusiness owners. The hours-per-week ranged from zero to ninety for the business owners as compared to an upper limit of seventy hours for nonbusiness owners.

C. Data Analysis

The data analyses were applied in four phases. The four characteristics of interest, i.e., telecommuters' background, employment, residential and occupation characteristics, are used

TABLE I
DESCRIPTIVE STATISTICS AND TESTS OF SIGNIFICANCE FOR THE NUMBERS OF HOURS-PER-WEEK BUSINESS ACTIVITIES ARE PERFORMED FROM HOME BY TELECOMMUTERS' BACKGROUND, EMPLOYMENT, RESIDENCE, AND OCCUPATION CHARACTERISTICS

	Number in Sample	Mean	Median	St. Dev.	Number of Hours Range	t-value/ F value	Probability
EDUCATION						0.57	0.567
Some College, H.S. grad, etc. (E1)	165	11.194	4	16.089	0<= hrs <=70		
Undergraduate Masters & Ph.D. (E2)	198	10.242	4	15.495	0<= hrs <=90		
AGE						-0.7	0.487
44 years & younger (A1)	179	10.05	3	15.154	0<= hrs <=84		
45 years & older (A2)	184	11.201	5	16.351	0<= hrs <=90		
SEX						-0.58	0.56
Females (F)	111	9.883	3	14.643	0 <= hrs <= 65		
Males (M)	252	10.933	4	16.26	0 <= hrs <= 90		
INCOME						-1.57	0.118
50K and less (I1)	237	9.435	4	14.213	0 <= hrs <= 84		
More than 50 K (I2)	101	12.267	5	17.339	0 <= hrs <= 80		
EMPLOYMENT						5.32	.000 *
Business Owners (BO)	152	14.704	6	19.217	0 <= hrs <= 90		
Non-business Owners (NBO)	168	5.827	2	9.418	0 <= hrs <= 70		
RESIDENCE						0.4236	0.655
Urban (U)	59	8.983	2	15.049	0 <= hrs <= 84		
Suburban (S)	204	11.103	4	16.714	0 <= hrs <= 90		
Rural (R)	103	10.379	5	14.084	0 <= hrs <= 70		
OCCUPATION						1.33	0.2633
Construction & Manufacturing (G1)	41	11.634	4	17	0 <= hrs <= 90		
Wholesale & Retail (G2)	51	10.549	4	15.089	0 <= hrs <= 65		
Transportation, Finance Real Estate, Services (G3)	161	13.36	5	18.425	0 <= hrs <= 84		
Agriculture Mining & Others (G4)	61	8.623	4	10.259	0 <= hrs <= 40		

as exogenous determinants of the present and planned usage of computer and communication technologies at home and outside home in a series of regression models. A series of multiple regression models were constructed to explore the significance and explanatory power of each of these characteristics.

D. Regression Models—Exogenous Determinants of Usage of Computer and Communication Technologies

The primary focus of these models is to provide a means of assessing the nature of the relationship between the predictors (determinants) and each of the dependent variables.[11] The dependent variables for each model represent telecommuters': 1) present usage (at home and outside the home) and 2) planned usage (at home and outside the home) of computer and communication technologies. The independent variables are qualitative, with two or more categories. We used a set of dichotomous variables, known as dummy variables, that act as replacement predictor variables. Any qualitative variable with k categories can be represented as $k-1$ dummy variables.[12]

Table II shows the determinants of telecommuters' present usage of technologies at home. The models explain 3%–9% of the variability in usage, and the F-ratios indicate that all models, except the one developed for credit card verification, were statistically significant at the 0.05 level. These results suggest that the models contribute useful information for the prediction of technology usage.

Results on the telecommuters' background characteristics show that telecommuters with an undergraduate, Master's, or Ph.D. degree report significantly higher usage of computers, modems, and electronic mail than those without a degree. This may be attributable to the exposure, necessity, and expectations for these technologies that often times are involved in obtaining

[11]It was not our intent to propose and test theoretical propositions about the interrelationships among variables in a multivariate setting. That said, our models should be viewed as a guide that allowed the researchers to assess the relative strengths of each determinant variable included in explaining the usage of computer and communication technologies. Our models are recursive insofar as it is assumed that reciprocal causation in the form of causal feedback loops does not exist. Although this assumption may not be totally justified, causal feedback loops have not yet been demonstrated empirically in the literature. Therefore, regression models are developed to evaluate the determinants of telecommuters' present and planned usage of technologies at home and outside the home.

[12]For example, in measuring the impact of telecommuters' age with a qualitative variable with two categories, we create two dummy variables ($A1$ and $A2$) that make the model function

$$A1 = 1, \text{ if age } < 45; \text{ else } A1 = 0$$
$$A2 = 1, \text{ if age } \geq 45; \text{ else } A2 = 0.$$

Both variables $A1$ and $A2$ are not necessary because when $A1$ equals zero, age must be by definition 45 years or older. Thus, we include only one of the variables ($A1$ or $A2$) to test the effect of the telecommuters age on usage of technologies. Correspondingly, for all determinant variables with two or more levels, we omit the first category.

TABLE II
DETERMINANTS OF TELECOMMUTERS' PRESENT USAGE OF TECHNOLOGIES AT HOME

	Computer Y1	Modem Y2	Fax Y3	Electronic Mail Y4	Credit Card Verification Y5	Multiple Phone Lines Y6	Computer Information Network Y7
Intercept	1.4995 5.417 (.000)	.8065 4.5089 (.000)	1.129 8.088 (.000)	.7168 6.435 (.000)	1.0293 18.082 (.000)	1.5157 5.703 (.000)	.9859 6.987 (.000)
EDUCATION							
E2 Undergarduate Masters & Ph.D.	**.153** **2.766** **(.0060)**	**.135** **2.445** **(.0150)**	[.003] [.071] (.9433)	**.157** **2.821** **(.0051)**	[.057] [.992] (.3218)	[.25] [.450] (.6526)	.067 1.181 (.2386)
AGE							
A2 45 years & older	[.003] [.067] (.9465)	.090 1.645 (.1008)	**.131** **2.334** **(.0202)**	**.183** **3.307** **(.0011)**	[.001] [.026] (.9790)	**.130** **2.360** **(.0188)**	.027 .368 .7132
SEX							
M Males	[.015] [.299] (.7649)	.001 .027 (.9784)	[.059] [1.113] (.2665)	[.011] [.208] (.8357)	[.104] [1.888] (.0600)	[.057] [1.078] (.2820)	.062 1.143 (.2537)
INCOME							
I2 More than 50 k	.076 1.464 (.1440)	**.145** **2.743** **(.0064)**	.010 .193 (.8472)	.071 1.340 (.1813)	[.012] [.223] (.8235)	[.047] [.887] (.3758)	.045 .828 (.4084)
EMPLOYMENT							
NBO Non-business Owners	**[.140]** **2.446** **(.0150)**	**[.021]** **[.370]** (.7119)	**[.152]** **[2.673]** **(.0105)**	.115 1.955 (.0514)	.019 .313 (.7543)	**[.148]** **[2.517]** **(.0123)**	**[.032]** **[.540]** (.5896)
RESIDENCE							
S Suburban	**.181** **2.539** **(.0116)**	**.143** **2.003** **(.0459)**	.057 .794 (.4279)	.088 1.223 (.2222)	.021 .292 (.7704)	**.1541** **2.155** **(.0319)**	.1350 1.850 (.0652)
R Rural	.097 1.088 .2772	.060 .839 (.4020)	.030 .418 (.6761)	.089 1.235 (.2177)	.041 .545 (.5860)	.046 .635 (.5259)	[.031] [.432] (.6661)
OCCUPATION							
G2 Wholesale & Retail	[.013] .211 (.8332)	.074 1.193 (.2335)	.026 .415 (.6782)	.096 1.519 (.1298)	.050 .767 (.4439)	[.004] [.076] (.9394)	.006 .100 (.9200)
G3 Transportation, Finance Real Estate, Services	.072 1.080 (.280)	.047 .703 (.4827	.081 1.200 (.2308)	.111 (1.646 (.1008)	.086 1.228 (.2203)	.092 1.378 (.1692)	.072 1.055 (.2920)
G4 Agriculture Mining & Others	[.011] [.183] (.8546)	[.054] [.892] (.3730)	.056 .900 (.3686)	.034 .558 (.5771)	.082 1.290 (.1981)	.056 .909 (.3641)	[.046] [.750] .4535
Adj. R2	0.0578	0.0628	0.03228	0.09413	0.0073	0.045	0.0273
S (error)	1.35	0.8717	0.677	0.5335	0.272	1.309	0.6809
F Ratio	3.22	3.388	2.174	3.491	0.748	2.865	1.98334
(Prob.)	0.0006	0.0003	0.0189	0.0002	0.6785	0.0019	0.0343

Notes:
(1) Y1 to Y7 represent **present usage** of computer and communication technologies **at home**
(2) the three values in each cell are beta coefficient, t-value and probability respectively
(3) Bold results are siginificant at p<= .05 levels
(4) Negative numbers are in bracketts

a college education. Differences in usage of technologies based on the telecommuters' age were apparent. Telecommuters 45 years and older use fax machines, electronic mail, and multiple phone lines significantly more often than telecommuters less than 45 years of age. We would have suspected that younger telecommuters (less than 45 years of age) would be more receptive to using computer information networks, but this was not the case. The telecommuters' annual income had an impact on usage of certain technologies. Telecommuters with an income of more than $50 000 use modems significantly more often than those with $50 000 and less income.

Results on the telecommuters' employment characteristics show a significantly lower usage of computers, fax machines, and multiple phone lines among nonbusiness owners relative to business owners.

The telecommuters residence emerges as a significant determinant of computer, modem, and multiple phone line usage. Specifically, we find that telecommuters in the suburbs use these technologies significantly more frequently than urban telecommuters. This is a reasonable finding, because one would expect that the isolation and distance of suburban telecommuters from their employers and/or customers would cause them to rely more heavily on these technologies as their means of contact.

Finally, the results in Table II suggest that gender and occupational characteristics were not significant determinants of usage of technologies at home. It is clear that male telecommuters usage of technologies was not significantly different from that of female telecommuters, and none of the three occupation groups differed significantly in usage from the construction and manufacturing telecommuters. Additionally, no significant determinants were found for predicting the present usage of credit card verification machines or computer information networks.

In Table III, we summarize regression models developed to identify determinants of telecommuters' planned usage of technologies at home. Overall, the proportion of variability in planned usage explained by these models is between 3% and 11%. Although, the determinants explain a moderate amount of variability in planned usage, the adequacy of the models is supported by significant F ratios.

Examining the telecommuters background characteristics, it shows a somewhat similar finding to those noticed in Table II, with one exception. No significant difference for gender was found for present usage of technologies at home, however, for planned usage we find that male telecommuters (compared to females) plan significantly less use of computers, modems, electronic mail, credit card verification, multiple phone lines,

TABLE III
DETERMINANTS OF TELECOMMUTERS' PLANNED USAGE OF TECHNOLOGIES AT HOME

	Computer Y1	Modem Y2	Fax Y3	Electronic Mail Y4	Credit Card Verification Y5	Multiple Phone Lines Y6	Computer Information Network Y7
Intercept	2.406 8.237 (.0000)	1.245 5.547 (.000)	1.383 6.783 (.0000)	.090451 5.284 (.000)	1.3349 13.267 (.000)	1.9538 7.219 (.000)	1.606 7.564 (.000)
EDUCATION							
E2 Undergarduate Masters & Ph.D.	**.130** **2.289** **(.0227)**	**.129** **2.293** **(.0225)**	.065 1.201 (.2306)	.098 1.697 (.0906)	[.108] [1.865] (.0631)	[.025] [.435] (.6642)	.064 1.128 (.2600)
AGE							
A2 45 years & older	.029 .524 (.6006)	.054 .986 (.3249)	.061 1.120 (.2634)	**.142** **2.483** **(.0135)**	.055 .969 (.3334)	**.122** **2.147** **(.0326)**	[.015] [.267] (.7899)
SEX							
M Males	**[.195]** **3.592** **(.0004)**	**[.195]** **[3.633]** **(.0003)**	[.067] [1.293] (.1968)	**[.132]** **2.395** **(.0172)**	**[.156]** **[2.822]** **(.0051)**	**[.126]** **[2.288]** **(.0228)**	**[.115** **[2.109]** **(.0357)**
INCOME							
I2 More than 50 k	[.007] [.136] .8922	**.147** **2.736** **(.0066)**	.039 .752 (.4525)	.100 1.811 (.0711)	[.035] [.630] (.5293)	.016 .291 (.7715)	.054 .982 (.3268)
EMPLOYMENT							
NBO Non-business Owners	[.089] [1.487] (.1380)	[.017] [.292] (.7702)	**[.267]** **[4.631]** **(.0000)**	.056 .907 (.3651)	[.107] [1.725] (.0854)	**[.205]** **[3.394]** **(.0008)**	[.126] [2.075] (.0387)
RESIDENCE							
S Suburban	.131 1.770 (.0776)	**.180** **2.476** **(.0138)**	**.158** **2.184** **(.0296)**	**.148** **1.975** **(.0491)**	[.141] [1.862] (.0635)	.033 .446 (.6561)	.076 1.029 (.3044)
R Rural	.073 .986 (.3247)	.049 .669 (.5042)	.123 1.703 (.0896)	.103 1.372 (.1710)	[.073] [.957] (.3392)	[.014] [.196] (.8449)	[.073] [.983] (.3262)
OCCUPATION							
G2 Wholesale & Retail	[.009] [.154] (.8775)	.003 .053 (.9577)	[.023] [.377] (.7067)	.074 1.118 (.2642)	.057 .866 (.3872)	[.067] [1.036] (.3010)	[.005] [.089] (.9295)
G3 Transportation, Finance Real Estate, Services	.062 .910 (.3635)	.020 .298 (.7660)	.072 1.085 (.2785)	.017 .237 (.8130)	.073) 1.028 (.3047)	.049 .722 (.4706)	.036 .517 (.6055)
G4 Agriculture Mining & Others	.035 .560 (.5759)	.014 .230 (.8181)	.010 .174 (.8623)	.019 .301 (.7636)	.088 1.373 (.1707)	.045 .714 (.4759)	[.077] [.118] (.9060)
Adj. R2	0.0523	0.11	0.095	0.04795	0.03697	0.05252	0.03046
S (error)	1.3871	1.045	0.96777	0.79338	0.46466	1.28209	0.99478
F Ratio	2.87025	4.0145	4.62017	2.6596	2.27458	2.83493	2.06843
(Prob.)	0.0019	0. 000	0. 000	0.004	0.0139	0.0022	0.0265

Notes:
(1) Y1 to Y7 represent **planned usage** of computer and communication technologies **at home**
(2) The three values in each cell are beta coefficient, t-value and probability respectively
(3) Bold results are siginificant at p<= .05 levels
(4) Negative numbers are in bracketts

and computer information networks. Telecommuters with undergraduate, Master's, or Ph.D. degrees intend to use computers and modems significantly more often than those telecommuters with less formal education. Planned usage of electronic mail and multiple phone lines was significantly higher among telecommuters 45 years and older as compared to those under 45. Telecommuters with incomes of more than $50 000 propose that they will use modems significantly more than those telecommuters with incomes less than this.

Results on telecommuters' employment characteristics show that nonbusiness owners will plan to use fax machines and multiple phone lines significantly less than a business owner. The outlook pertaining to the usage of modems, fax machines, and electronic mail is that these technologies will be used more regularly by suburban, as compared to urban and rural, telecommuters. Electronic mail certainly becomes a valuable technology for telecommuting. The intent to use it more frequently is not surprising, since electronic mail facilitates communication between geographically dispersed colleagues and, conversely, may permit someone to work effectively at home instead of at the office. This finding is in consonance with Kriebel and Strong [43], who found a high correlation between telecommuting and electronic mail usage. Finally, the occupation characteristics of the telecommuter has no significant bearing on the planned usage and present usage of technologies at home.

Table IV shows the determinants of the present usage of these technologies outside the home. The proportion of variability in present usage of technologies outside the home, which is explained by the determinants, is about 8%–16% and the adequacy of the models is supported by F ratios that are significant at the less than or equal 0.05 level.

Table IV shows that telecommuters with a college education report significantly higher usage of computers as compared to those with only a high school education. Furthermore, they presently use fax machines outside their home more often as well. The telecommuters' age is a significant determinant of outside home usage of fax machines, electronic mail, multiple phone lines and computer information networks. Specifically, usage of these technologies is higher among the 45 years of age and older telecommuter than those less than 45. Also the results show that males presently use computers and multiple phone lines significantly less than females. Interestingly, the telecommuters' income had no significant effect on usage of any of the technologies outside home, whereas the telecommuters' employment characteristics significantly influenced the usage

TABLE IV
DETERMINANTS OF TELECOMMUTERS' PRESENT USAGE OF TECHNOLOGIES OUTSIDE HOME

	Computer Y1	Modem Y2	Fax Y3	Electronic Mail Y4	Credit Card Verification Y5	Multiple Phone Lines Y6	Computer Information Network Y7
Intercept	1.8714 4.343 (.0000)	1.432356 4.134 (.0001)	1.475362 4.083 (.0001)	1.063299 3.231 (.0015)	1.559499 5.960 (.0000)	2.485253 5.206 (.0000)	.814584 2.866 (.0047)
EDUCATION							
E2 Undergarduate Masters & Ph.D.	.224 3.081 .0024	.121 1.576 (.1168)	.178 2.406 (.0172)	.115 1.521 (.1301)	.065 .874 (.3835)	.017 .234 (.8152)	.056 .743 (.4584)
AGE							
A2 45 years & older	.034 .477 (.6338)	.141 1.853 (.0655)	.185 2.503 (.0132)	.168 2.228 (.0272)	[.139] [1.861] (.0645)	.184 2.489 (.0137)	.150 1.991 (.0480)
SEX							
M Males	[.178] [2.622] (.0095)	[.102] [1.430] (.1545)	[.127] [1.839] (.0676)	[.033] [.476] (.6348)	[.035] [.496] (.6203)	[.255] [3.678] (.0003)	[.035] [.506] (.6135)
INCOME							
I2 More than 50 k	.074 1.053 (.2937)	[.010] [.142] (.8872)	[.042] [.597] (.5513)	.020 .276 (.7829)	[.047] [.643] (.5211)	[.043] [.607] (.5449)	[.018] [.246] (.8063)
EMPLOYMENT							
NBO Non-business Owners	.367 4.508 (.0006)	.223 2.778 (.0001)	.249 3.205 (.0016)	.293 3.669 (.0002)	.016 .209 (.8346)	.189 2.476 (.0163)	.272 3.448 (.0007)
RESIDENCE							
S Suburban	[.011] [.117] (.9072)	[.050] [.495] (.6210)	.059 .614 (.5397)	[.004] [.049] (.9606)	[.142] [1.484] (.1397)	[.018] [.189] (.8501)	.050 .508 (.6123)
R Rural	[.139] [1.457] (.1469)	.005 .056 (.9552)	[.070] [.718] (.4734)	[.052] [.525] (.0006)	[.248] [2.495] (.0135)	[.138] [1.409] (.1607)	.010 .105 (.9163)
OCCUPATION							
G2 Wholesale & Retail	.044 .541 (.5891)	.032] [.370] (.7118)	.104 1.244 (.2151)	[.025] [.292] (.7704)	.308 3.610 (.0004)	.019 .227 (.8209)	.083 .976 (.3304)
G3 Transportation, Finance Real Estate, Services	.169 1.930 (.0490)	.101 1.097 (.2741)	.121 1.358 (.1761)	.019 .210 (.8341)	.092 1.017 (.3106)	.174 1.950 (.0528)	.274 3.018 (.0029)
G4 Agriculture Mining & Others	[.059] [.715]	[.145] 1.641] (.1025)	[.116] [1.367] (.1733)	[.075] .862] (.3900)	[.090] [1.039] (.3002)	[.030] .361] (.7183)	[.070] [.811] (.4185)
Adj. R2	0.16187	0.06167	0.12552	0.08247	0.09556	0.1228	0.08966
S (error)	1.51877	1.22122	1.2735	1.15983	0.9207	1.68261	1.00175
F Ratio	4.63097	2.23556	3.69859	2.68972	2.98626	3.63193	2.85163
(Prob.)	(. 000)	(0. 0177)	(. 0002)	(. 0043)	(. 0017)	(. 0002)	(. 0026)

Notes:
(1) Y1 to Y7 represent **present usage** of computer and communication technologies **outside home**
(2) The three values in each cell are beta coefficient, t-value and probability respectively
(3) Bold results are siginificant at p<= .05 levels
(4) Negative numbers are in bracketts

of all technologies except credit card verification. The nonbusiness owner reported significantly higher usage of these technologies outside their home than business owners. Although suburban telecommuters tended to use many of the technologies less than telecommuters in urban areas, it was not significantly less. This is in sharp contrast to the results observed for present and planned usage of technologies at home where we observed that several technologies were used significantly more by them as compared to urban telecommuters. We did, however, observe that rural telecommuters' usage of credit card verification machines was significantly less than that by urban telecommuters. This result was not found for the present and planned usage of this technology at home.

Lastly, the telecommuters' occupations had an impact on usage outside the home for some technologies, a finding not observed for either present or planned usage of technologies at home. Telecommuters in the wholesale and retail industry, as compared to those in the construction and manufacturing industry, reported a significantly higher usage of credit card verification machines. Likewise, telecommuters in the transportation, finance, real estate, or services industries were using computers and computer information networks significantly more than those in the manufacturing and construction sectors.

Table V shows the determinant of planned usage of technologies outside the home. The model explained 7%–23% of the variation in usage, and the adequacy of the models is further substantiated by F ratios that are significant at less than or equal 0.05.

The finding suggests that telecommuters with college degrees use computers, modems, fax machines, and electronic mail significantly more than telecommuters who do not have a degree. Furthermore, a significantly higher usage of electronic mail and credit card verification machines were discovered by telecommuters 45 years and older in contrast to those less than 45 years of age. We noticed that male telecommuters use the technologies much less than females. In fact, they use computers, modems, and multiple phone lines significantly less than females. The income of the telecommuter was not a significant determinant of planned technology usage outside the home.

The telecommuters' residence was an effective determinant of planned usage for computers, modems, fax machines, electronic mail, and computer information networks. The results suggest that the nonbusiness owner will use these technologies outside their home significantly more than the business owner. This finding is contrary to our results observed in Tables II and III, where the nonbusiness owner used these technologies at

TABLE V
DETERMINANTS OF TELECOMMUTERS' PLANNED USAGE OF TECHNOLOGIES OUTSIDE OF HOME

	Computer Y1	Modem Y2	Fax Y3	Electronic Mail Y4	Credit Card Verification Y5	Multiple Phone Lines Y6	Computer Information Network Y7
Intercept	1.7712 4.338 (.0000)	1.263414 3.502 (.0006)	1.318309 3.615 (.0004)	1.060609 3.046 (.0027)	1.494970 5.572 (.0000)	2.161972 4.586) (.0000)	.781696 2.313 (.0218)
EDUCATION							
E2 Undergarduate Masters & Ph.D.	.234 3.379 (.0009)	.169 2.284 (.0235)	.185 2.527 (.0124)	.149 1.990 (.0480)	.083 1.093 (.2759)	.024 .336 (.7370)	.025 .334 (.7386)
AGE							
A2 45 years & older	.118 1.721 (.0869)	.122 1.660 (.0987)	.129 1.778 (.0771)	.153 2.050 (.0418)	[.195] [2.562] (.0110)	.140 1.913 (.0574)	.106 1.423 (.1565)
SEX							
M Males	[.238] [3.685] (.003)	[.191] [2.767] (.0063)	[.131] [1.911] (.0576)	[.126] [1.1802] (.0732)	[.048] [.679] (.4977)	[.265] 3.853] (.0002)	[.074] [1.066] (.2879)
INCOME							
I2 More than 50 k	.102 1.533 (.1270)	.700 1.397 (.1642)	.051 .723 (.4705)	.037 .576 (.6063)	[.109] [1.475] (.1419)	.006 .095 (.9242)	.042 .586 (.5588)
EMPLOYMENT							
NBO Non-business Owners	.211 2.915 (.0040)	.168 2.160 (.0321)	.163 2.124 (.0350)	.255 3.248 (.0014)	[.098] [1.235] (1.2185)	.121 1.574 (.1172)	.168 2.136 (.0340)
RESIDENCE							
S Suburban	.127 1.403 (.1624)	.167 (1.716) (.0878)	.255 2.652 (.0087)	.190 2.652 (.0087)	.091 .916 (.3609)	.162 1.678 (.0957)	.226 2.292 (.0231)
R Rural	[.014] [.164] (.8700)	.052 (.537 (.5918)	.056 .583 (.5608)	.094 .961 (.3377)	[.061] [.617] (.5384)	[.005] [.051] (.9590)	.066 .674 (.5011)
OCCUPATION							
G2 Wholesale & Retail	[.021] [.273] (.7848)	[.040] [.479] (.6325)	[.025] [.306] (.7596)	[.037] [.436] (.6631)	.199 2.310 (.0220)	[.093] [1.121] (.2636)	[.007] [.087] (.9305)
G3 Transportation, Finance Real Estate, Services	.182 2.191 (.0297)	.041 .457 (.6479)	.045 .575 (.6071)	[.041] [.466] (.6417)	.090 .992 (.3224)	.129 1.460 (.1461)	.238 2.643 (.0090)
G4 Agriculture Mining & Others	[.052] [.662] (.5090)	[.117] [1.383] (.1684)	[.144] [1.712] (.0886)	[.110] [1.281] (.2017)	[.041] [.470] (.6391)	.008 .099 (.9213)	.013 .51 (.8800)
Adj. R2	0.2378	0.12755	0.14479	0.10701	0.07548	0.13618	0.1001
S (error)	1.43898	1.27147	1.28545	1.22736	0.9559	1.6615	1.19092
F Ratio	6.86553	3.74839	4.18283	3.25277	2.53499	3.96375	3.09112
(Prob.)	(. 0000)	(. 0001)	0. 000	(. 00707)	(. 0070)	(. 0001)	(. 0012)

Notes:
(1) Y1 to Y7 represent **planned usage** of computer and communication technologies **outside home**
(2) The three values in each cell are beta coefficient, t-value and probability respectively
(3) Bold results are siginificant at p<= .05 levels
(4) Negative numbers are in bracketts

their home, significantly less than the business owners. Further, the present and planned usage (outside the home) of electronic mail and fax machines is significantly more by nonbusiness owners than business owners. Also, suburban telecommuters working outside their home planned to use fax machines and computer information networks significantly more than urban telecommuters.

The results on telecommuters' occupations show that telecommuters in the wholesale and retail industries plan to use credit card verification machines significantly more than telecommuters in manufacturing and construction. The planned usage of computers and computer information networks is significantly higher among telecommuters in transportation, finance, real estate, and services, as compared specifically to manufacturing and construction industries. This finding appears consistent for industries that are highly information intensive.

V. SUMMARY AND CONCLUSION

Table VI shows the overall summary of the significant determinants given in Tables II–V. This summary shows that our hypothesis P1) was partially supported by the results. We examined four background characteristics of the telecommuters education, age, sex, and income. The results show that the telecommuters' education level is a significant determinant for usage of computers, modems, electronic mail, and fax machines. The telecommuters' age was not a significant predictor of usage of computers and modems. It was, however, a significant predictor for the usage of the rest of the technologies: fax, electronic mail, multiple phone lines, computer information network, and credit card verification machines. The telecommuters' gender was a significant predictor for present/planned usage of some technologies outside the home. Although the telecommuters' gender was the only characteristic that was not a significant predictor for present usage of any of the technologies at home, it was however, a significant predictor for planned usage of some technologies at home. The telecommuters' income was only a significant predictor for present and planned usage of a modem at home.

Our second hypothesis, P2), was fully supported. We found that telecommuters' employment was a significant predictor for present and planned usage of some technologies, both at home and outside the home. The nonbusiness owners' at-home present and planned usage of computer, fax, and multiple phone lines was significantly lower than that of business owners.

TABLE VI
SUMMARY OF SIGNIFICANT DETERMINANTS OF TECHNOLOGY USAGE

	Present usage at home	Planned usage at home	Present usage outside home	Planned usage outside home
EDUCATION				
Some College, H.S. grad, etc. (E1)				
Undergraduate Masters & Ph.D. (E2)	Computer, Modem, Electronic mail	Computer,Modem	Computer, Fax	Computer, Modem, Fax, Electronic Mail
AGE				
44 years & younger (A1)				
45 years & older (A2)	Fax, Electronic Mail, Multiple Phone Lines	Electronic Mail, Multiple Phone Lines	Fax, Electronic Mail, Multiple Phone Lines, Computer Information Network	Electronic Mail, Credit Card Verification
SEX				
Females (F)				
Males (M)		[Computer], [Modem], [Electronic Mail], [Credit Card Verification], [Multiple Phone Lines], [Computer Information Network]	[Computer], [Multiple Phone Lines]	[Computer], [Modem], [Multiple Phone Line]
INCOME				
50K and less (I1)				
More than 50 K (I2)	Modem	Modem		
EMPLOYMENT				
Business Owners (BO)				
Non-business Owners (NBO)	[Computer], [Fax], [Multiple Phone Lines]	[Fax], [Multiple Phone Lines]	Computer, Modem, Fax, Electronic Mail, Multiple Phone Lines, Computer Information Network	Computers, Modem, Fax, Electronic Mail, Computer Information Network
RESIDENCE				
Urban (U)				
Suburban (S)	Computer, Modem, Multiple Phone Lines	Modem, Fax, Electronic Mail		Fax, Electronic Mail, Computer Information Network
Rural (R)			Electronic Mail, Credit Card Verification	
OCCUPATION				
Construction & Manufacturing (G1)				
Wholesale & Retail (G2)			Credit Card Verification	Credit Card Verification
Transportation, Finance Real Estate, Services (G3)			Computer, Computer Information Network	Computer, Computer Information Network
Agriculture Mining & Others (G4)				

Notes:
(1) Technologies in brackets indicate a significantly lower usage by that group
(2) For all determinants, the first category is the omitted category

However, nonbusiness owners' outside the home present and planned usage of computer, modem, fax, electronic mail, and computer information network was significantly greater than business owners.

The results also partially support hypothesis P3). That is, the telecommuters' residence was a significant predictor for present/planned usage of some technologies at home and outside the home. Suburban telecommuters indicated a significantly higher present and planned usage of technologies at home than those residing in urban and rural areas. On the other hand, while present usage outside the home by suburban telecommuters was not significantly different from other telecommuters, the planned usage was.

Lastly, our results partially support hypothesis P4). That is the telecommuters' occupation was only a significant predictor of the outside the home usage of computer, computer information network, and credit card verification machines. The results indicate that the telecommuters' occupations, however, had no effect on present or planned usage of technologies at home.

A. Discussion and Implications

Our results indicate that the telecommuters with college degrees tend to have a higher usage of computer, electronic mail, and modems at home. This may be due to the fact that these individuals are exposed to these technologies as a necessity when they are in college. Further, for companies which offer telecommuting to their employees, it is important to improve the security since the usage of these technologies is highest among college graduates, and they are more likely to have the knowledge and ability to violate the security. In addition, since the planned at-home usage of some technologies, such as computer and computer information network, are significantly lower for males than it is for female telecommuters, the professional education programs must focus more toward female telecommuters who are working from home.

The study has also shown that an increasing number of telecommuters will perform business activities from their homes. Companies should offer more telecommuting options for jobs that can easily be done from home. Moreover, by offering telecommuting options to employees, companies can be viewed as more socially responsible by their employees. The managers of these companies must learn new ways to combat the prevalent mistrust that telecommuters could be as productive while unsupervised and to interact with those employees who work from their homes. Our results also indicate the usage of computer, electronic mail, fax, and computer information networks are significantly higher among telecommuters living in suburban areas than those living in urban and rural areas. The supplier of these technologies should fine tune their marketing efforts to the special needs

of the people in suburban areas. This study also helps the technology providers in better understanding the needs of their customers. Understanding such needs have been one of the weakest areas in marketing of the telecommunication technologies [22]. For the technology providers, this study clarifies the special needs of urban, suburban, and rural customers and thus helps information technology providers focus their energies on those customers where the returns are significantly higher.

For researchers, this paper has provided an empirical study of large (375 business and residential) groups of telecommuters. This study has shown that some of the background, employment, residential, and occupational characteristics of telecommuters are significant predictors for usage of computer and communication technologies. Most of the previous studies on determinants of microcomputer usage were conducted without consideration for differences that may exist in background, employment, residential and occupational characteristics of the participants in the studies (e.g., [33], [73]). Although such studies are important in identifying factors that impact perceived and actual information technology usage, they are, however, lacking generalization of the findings from the participants in the studies to the general population of interest. Further, empirical studies on telecommuting and on the impact of usage of computer and communication technologies on productivity of white collar employees should control for these characteristics. In addition, previous research has shown that the availability of an information technology does not automatically guarantee its utilization by employees [29]. Future research should investigate how can managers motivate employees to telecommute in order to slash costs.

B. Limitations and Future Research

Kraut [35] argued that research on telecommuters' characteristics requires a large sample, which is often beyond the means of standard small-scale academic research. The results, therefore, must be treated with caution due to some inherent limitations. First, the distinction between self-employed (business owners) and employee status is less clear for telecommuters than for conventional workers, because of employers' practices and because of conflicting definitions administered by the Internal Revenue Service (IRS) and the U.S. Department of Labor [19]. Several telecommuters were unwilling to accept that they work at home because, in many instances, they are a part of the underground economy and fear revealing the existence of work that was not reported to IRS. On the other hand, some respondents may fabricate an at-home business or at-home work to acquire tax advantages. Second, the data were collected from residential and business customers of a regional phone company in the U.S. southern states. This helped increase the internal validity of the research by minimizing the effects of differences among states. However, this limited the generalizability of the results, especially since states within the United States may differ with respect to traffic congestion, office/housing cost, progress in telecommunication with respect to high-speed transmission lines, multimedia technology, etc. Third, the distinction among urban, suburban, and rural was self-reported and may carry response errors. Future research may build on this study through replications in other states by using objective measures for the business and the residential classification. Fourth, the analyses in this study were based on responses by individual telecommuters and the data did not take into consideration their association with a specific employer. Finally, in this study we did not collect data on number and type of computer classes the respondents might have taken during their education. The extent to which they have acquired computer skills may influence their usage of computer and communication technologies.

Future research may collect data on jobs performed by respondents. Besides the four factors addressed in this research, i.e., telecommuters' background, employment, residential, and occupational characteristics, other factors, such as telecommuters' computer skill and task characteristics may be considered. Although in this study we have separated the microcomputer usage from the usage of communication technologies, future studies may focus on the kinds of technologies used by telecommuters for specific applications.

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Yash P. Gupta received the B.S. degree in engineering and the M. Tech. and Ph.D. degrees from the University of Bradford, U.K.

He is a Professor and Dean of the College of Business, University of Washington, Seattle. Previously he was Professor and Dean of the College of Business, University of Colorado at Denver. He was the Frazier Family Professor at the School of Business, University of Louisville, KY. He has also taught at the University of Manitoba, Canada, Memorial University, Canada, and the University of Bradford, U.K. He has consulted with large international companies, financial institutions, government agencies, and not-for-profit health care organizations in several countries, including England, France, the Netherlands, Belgium, Germany, Sweden, Switzerland, Canada, and the United States. His research interests are in the areas of planning and control systems for advanced manufacturing systems, information systems strategies, and total quality management. He teaches courses in management information systems and operations management. He is the author of more than 160 articles which have been published in numerous international journals. He serves on the editorial boards of four journals and has been invited to be guest editor for several journals.

Dr. Gupta is a recipient of numerous awards of excellence from various institutions and professional organizations, including the President's Award for Outstanding Scholarship, Research, and Creative Activity for 1991. In 1994 and 1996, he was ranked as the most prolific scholar in the area of operations management in the United States.

Jahangir Karimi received the Ph.D. degree in management information systems from the University of Arizona in 1983.

He is presently Professor of Information Systems and Serves as the Program Director for the Information Systems Program at the College of Business, University of Colorado at Denver. During the 1993–1994 academic year, he was on sabbatical leave at the University of Hong Kong's Department of Computer Science. His research interests include information technology management in national and international environments, information systems modeling, analysis and design, software engineering, and telecommuting. He has published in IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT, *Management Information Systems Quarterly*, *Communications of the ACM*, *Journal of Management Information Systems*, *Journal of Systems and Software*, *Concurrency Practice and Experience*, and a number of conference proceedings.

Dr. Karimi is a member of the Association for Computing Machinery, the Computing Society, and the Society for Information Management.

Toni M. Somers received the M.B.A. degree from Bowling Green State University, Bowling Green, OH, and the Ph.D. degree from the University of Toledo, OH.

She is currently Associate Professor and Interim Chair of Finance and Business Economics, School of Business Administration at Wayne State University, Detroit, MI. She teaches in the school's Professional Development Division's Certified Quality Specialist (CQS) Program for the UAW-Ford National Quality Committee and the Chartered Financial Analyst (CFA) Study Program. She previously taught at the University of Toledo and Bowling Green State University. Her teaching interests are in the areas of quantitative methods, quality management, and manufacturing strategy. She has published more than 20 papers in production, manufacturing, operations management, and management information systems (MIS) journals, including the *Journal of Management Information Systems*, *Production and Operations Management Journal*, *International Journal of Operations and Production Management*, IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT, IEEE TRANSACTIONS ON RELIABILITY, *European Journal of Operational Research*, *Manufacturing Review*, and *Journal of Manufacturing Systems*. In addition, she has published and presented papers at conferences both nationally and internationally. She is also an active *ad hoc* reviewer for several production/manufacturing journals. Her current research focuses on the impact of information technology management sophistication on the marketing and operations functions and its relationship to a firm's MIS steering committee.