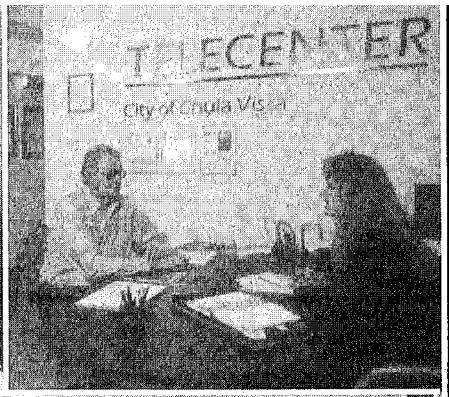

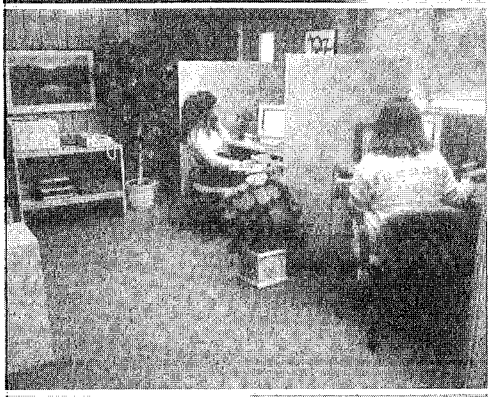

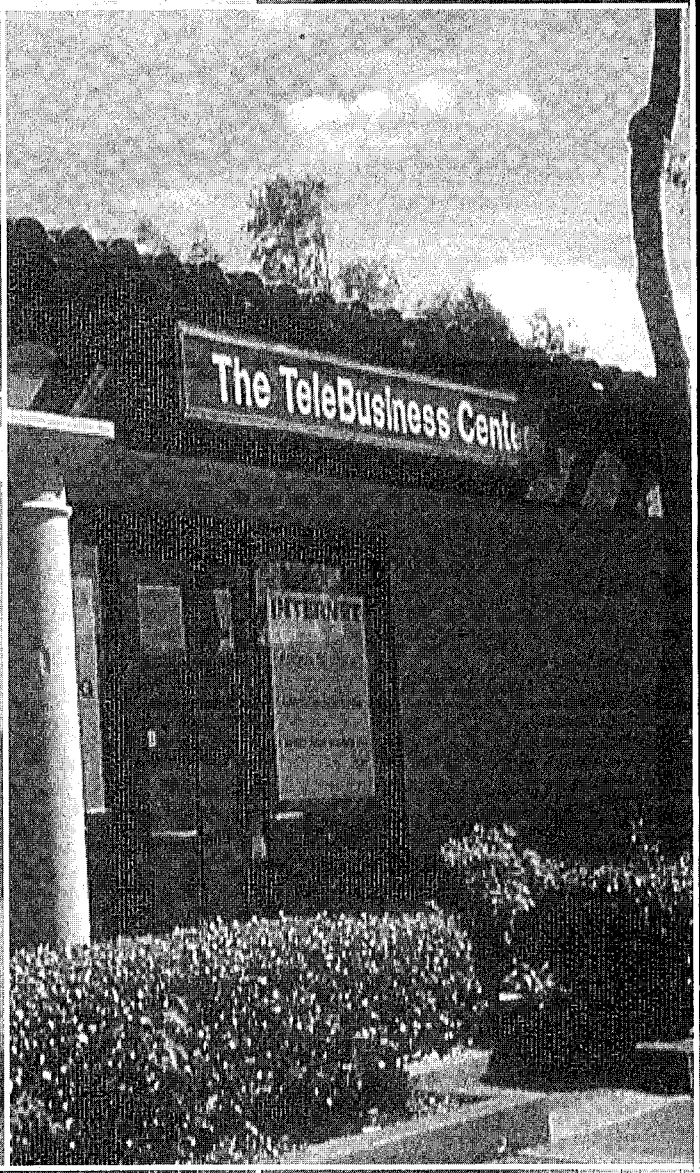

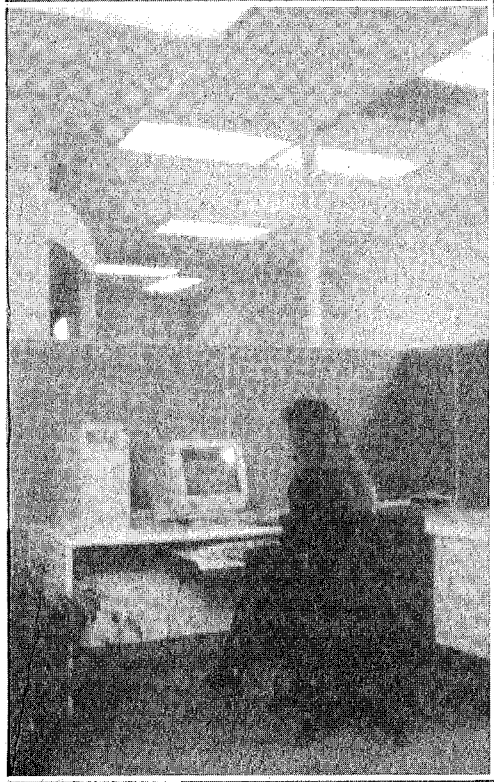

Residential Area-Based Offices Project: Interim Findings Report on the Evaluation of Impacts

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ABSTRACT

The Residential Area-Based Offices (RABO) Project, sponsored by the Federal Highway Administration and the California Department of Transportation, is designed to evaluate the effectiveness of telecommuting centers as an institutional work arrangement and as a transportation demand management strategy. The program has established a total of 15 telecenters, and evaluation data were collected from an additional 5 centers. In this volume, the impacts of these telecenters on work performance, job satisfaction, and travel behavior are evaluated. Four survey instruments were used to capture telecommuter behavior: an attitudinal survey, a travel diary, an attendance log, and an exit interview. Data collected through June 1995 were included in the analysis; data from an additional year of operation will be incorporated in a final report.

Despite efforts to locate centers close to residential areas in order to make walking and biking more attractive, most commuting to the telecommuting center took place by driving alone. Interestingly, there was a small, but significant, increase in the number of commute trips apparently largely due to telecommuters returning to the center after a trip home for lunch. Most importantly, the number of person-miles of travel decreased by an average of more than 74% for telecenter users on telecommuting days while the total number of trips remained constant. When this average is weighted by the average frequency of telecommuting, an average reduction of 19.2% in total weekday travel was found. However, it must be noted that the telecenter users lived much farther from work than non-telecommuting control group members (with average daily travel of 91 vs. 48 miles). So while telecommuters traveled less than non-telecommuters on telecommuting days, the telecommuters still traveled more in the aggregate (telecommuting and non-telecommuting days combined).

The sites established under the RABO Project had been open for between 2.5 and 20 months through June 1995. Average site occupancies ranged between 10 and 20% of available workspace days. The average telecommuting frequency was 25% (or 1¼ days per week) at these sites, compared to 17% at the non-RABO sites.

On the organizational side, 82% of the managers of telecenter users rated their level of satisfaction with telecommuting centers as high or very high. However a selection bias must be noted since managers who were dissatisfied were less likely to remain in the program long enough to complete the survey on which this result is derived. The perceived advantages of telecommuting (customer service and productivity) are difficult to quantify, while other more easily quantifiable factors (office space and parking costs) were not perceived to be advantages. While 39% of the manager respondents indicated that their organization was likely to offer center-based telecommuting to its staff, an equal proportion cited lowering the cost, being able to quantify the benefits, and increased manager acceptance as factors that needed to change before center-based telecommuting was likely to be offered.

The employee experience with telecommuting centers has been positive. Although no adverse impacts on productivity and job satisfaction have been found, a selection bias is also present here since the attitudinal data were obtained only for employees remaining in the program. Attrition at the telecenters was high: half of the telecenter users quit within nine months. Primary reasons for leaving relate to changes in job circumstances and supervisor desires rather than to employee dissatisfaction with telecommuting centers.

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DISCLAIMER

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REPORTS AVAILABLE FROM THE RABO PROJECT

Institute of Transportation Studies
University of California, Davis 95616

For additional information or to obtain any of these reports, contact Francisca Mar at 916-752-3378 (phone) or 916-752-7820 (fax).

Bagley, Michael N., Jill S. Mannering and Patricia L. Mokhtarian. *Telecommuting Centers and Related Concepts: A Review of Practice*, Summary. UCD-ITS-RR-94-3, March 1994. 61 pp. $10, or may be downloaded from the Internet free of charge.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Residential Area-Based Offices (RABO) Project, known informally as the Neighborhood Telecenter Project, is a multi-year program underway at the Institute of Transportation Studies, University of California, Davis. This research program, sponsored by the Federal Highway Administration and the California Department of Transportation, is designed to evaluate the effectiveness of telecommuting centers as an institutional work arrangement and as a transportation demand management strategy in California. The program has established a total of 15 telecenters, and evaluation data were collected from an additional 5 centers. This is a summary of the evaluation of impacts. A companion volume addresses the implementation and operation of the RABO telecenters.

This volume is an interim evaluation of telecommuting center use and its impacts on work performance, job satisfaction, and travel behavior. To that end, four survey instruments were developed to measure telecenter use and its effects at both RABO and non-RABO sites: an attitudinal survey, a travel diary, an attendance log, and an exit interview. The survey and diary were administered to participants once before and once after the start of telecommuting, the attendance log was used throughout the study period, and the interview was conducted with participants who left the program. The evaluation process provided data for analyses of travel impacts, telecommuter and manager attitudes, telecommuting retention, and telecommuting patterns. Data collected through June 30, 1995 were included in the analysis for this interim report; data from an additional year of operation will be incorporated into the final report which is due September 1997.

Overall, the interim experience with telecommuting centers has been positive, with some indicators that require continued monitoring. Employee reactions to center-based telecommuting have been favorable, and no adverse impacts on productivity and job satisfaction were measured. There may be a selection bias in these results as these data were obtained only for employees remaining in the program. However, reasons for leaving the program are discussed below. On average, telecenter users preferred to work from the regular workplace and the telecommuting center for approximately equal amounts. In particular, about 31% of the telecenter users also preferred to work at home for some part of the work week; however, according to current practice, home- and center-based telecommuting are seldom undertaken on the same day.

The transportation impacts of center-based telecommuting were complex. On the less desirable side, there was an increase in drive-alone trips and a decrease in trip chaining on telecommuting days. Most commuting to the telecenter took place by driving alone, despite efforts to locate centers sufficiently close to residential areas that walking and biking would be attractive commute modes. Interestingly, there was a small increase (of 0.5, significant at $\alpha = 0.02$) in the number of *commute* trips made on telecommuting days, apparently due to telecommuters making trips home for lunch and returning to the center in the afternoon. On the positive side, however, telecommuting did not adversely affect commute mode choices on non-telecommuting days. And most importantly, the number of person-miles traveled (PMT) decreased by an average of nearly 74% on telecommuting days, while the *total* number of trips made remained constant.

To place the PMT reduction in the proper perspective, it is important to realize two things. First, the reduction represents a comparison between travel on non-telecommuting weekdays and telecommuting weekdays for center-based telecommuters. Thus, the overall impact on travel will be a function of the frequency of telecommuting. When travel indicators on telecommuting and non-telecommuting days were weighted by the average frequency with which each type of day occurs, an average reduction of 19.2% in total weekday miles traveled by telecenter users was found.

Second, the telecommuters in this sample lived farther from work, and hence had a much greater average non-telecommuting day PMT, than the non-telecommuting control group members (90.9 vs. 47.9 miles). Although on telecommuting days the telecommuters traveled less than the control group, in the aggregate (telecommuting and non-telecommuting days combined) they still traveled more. If, in the future, telecommuting continues to be adopted primarily by long-distance commuters, the per capita reductions in travel will be considerable, but this change will be achieved by a limited segment of the market. If, on the other hand, the adoption of telecommuting is more universal, the per capita reductions in travel will be smaller, albeit achieved by a wider segment of the market. In either case, the specific reductions measured in this study will not be representative of the impacts for the population as a whole.

On the organizational side, managers of telecenter users were generally supportive, with 93% having a positive attitude toward telecommuting in general, and 82% rating their level of satisfaction with center-based telecommuting as high or very high. (However, a selection bias must be noted since managers who were dissatisfied with telecommuting would be less likely to remain in the program long enough to complete an after survey). Opinions of upper management tended to be more neutral according to the immediate supervisors of telecommuters. The perceived advantages of telecommuting were those for which the benefit is difficult to quantify (customer service and productivity), while telecommuting is not perceived to offer advantages on "hard" money items, such as office space and parking costs. This will continue to make center-based telecommuting difficult to justify in purely economic terms. Indeed, while 39% of the manager respondents indicated that the organization was likely to offer center-based telecommuting to its staff, an equal proportion cited lowering the cost, being able to quantify the benefits, and increased manager acceptance as factors that needed to change before the organization would be likely to offer center-based telecommuting.

Managers continued to view the regular workplace as the primary work location for their employees, to be used for at least three days per week on average. This expectation of part-time telecommuting may act to inhibit the adoption of the center-based form, as there will be little opportunity for the organization to re-use the telecommuter's space in the regular workplace.

Average site occupancies ranged between 10 and 20% of available workspace days, with a generally upward trend. The 10 RABO sites with sufficient attendance log data to be included in this report had been open a minimum of 2.5 months and a maximum of 20 months (average 9.1 months) through June 1995. It will be important to examine how site occupancy changes with an additional year of operation (July 1995 to June 1996). For those who used the centers at least twice, telecommuting frequencies averaged 25% (1¼ days per week) at RABO sites and 17% at non-RABO sites.

Attrition at the telecenters was relatively high: 50% of all telecommuters quit within nine months of starting to use the center. Although little comparative data are available, this appears to be higher than for home-based programs. Results of exit interviews, conducted with the 24 participants who quit after this program began and who could be reached, suggest that primary reasons for quitting relate to changes in job circumstances (25%) and to supervisor's desires (21%) rather than to employee dissatisfaction with telecommuting. Nevertheless, the frequency and duration of telecommuting are crucial factors to consider in any forecast of levels and impacts of telecommuting.

In summary, while transportation and other impacts are unequivocally positive on net for those who telecommute on the days they are telecommuting and for the duration of their telecommuting experience, concerns remain about high attrition among telecenter users and about the perceived cost-effectiveness of center-based telecommuting to organizations.

The additional data that are being collected after June 1995 (the arbitrary cutoff date for this interim report) will be used to confirm or revise the findings presented here. In addition, the full data set from the RABO evaluation will allow certain studies that were restricted by the small sample sizes in the interim data set. Possible studies based on the attitudinal survey data include the direct comparison of the employee's and his or her manager's attitudes about work and telecommuting and the comparison of telecenter users and control group characteristics and attitudes. The data collected as part of the RABO evaluation will also allow the development of models of telecommuting preference and choice that can be used to identify key factors in the decision to telecommute and to predict the frequency of future telecenter use. Finally, travel diary data can be utilized in investigations of the impact of telecommuting centers on air quality and travel at the household level.

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1 Objectives

This interim findings report on the Residential Area-Based Offices (RABO) Project focuses on the measurement of the impacts of telecommuting centers. The survey instruments employed in the evaluation process both measured telecommuting activity and assessed its impacts on work performance, job satisfaction, and travel behavior. The assessment presented here provides valuable information about the effectiveness of center-based telecommuting as a work option and as a travel demand management strategy.

An important objective of the RABO Project was to monitor and evaluate all telecommuting centers in California, both those set up under the RABO Project and those already in existence. UC Davis was tasked with formally evaluating up to five of these existing non-RABO centers (see Table 2-1 for a list of telecenters evaluated in this report). The centers that were opened separately from this project did not necessarily locate near residential areas, a criterion in the siting of RABO centers. As a result, the impacts of these non-RABO centers are likely to differ from the RABO centers in some ways, and these differences are noted where appropriate. In addition to the formal data collection from, and evaluation of, these five non-RABO sites, all known telecommuting centers in California were informally monitored. Periodic status tracking reports on all telecenters are listed in the front of this report among the group of documents produced by the RABO Project.

1.2 Evaluation Methodology

In order to investigate the impacts of telecenter use, a complex evaluation plan was developed that involves the administration of four data collection instruments, three groups of project participants, and three sub-categories within each group (see Tables 1-1a and b). The four survey instruments that are used to measure telecommuting behavior and its impacts are an attitudinal survey, a travel diary, a sign-in log, and an exit interview. The project participants include the telecommuting center users and two control groups: home-based telecommuters and non-telecommuters. In addition, for each group, the employee's manager and household members are surveyed as part of the investigation. As a result, the surveys were tailored to each group, where appropriate. In addition, the attitudinal survey and travel diary were given at two points in time so as to measure changes related to the implementation of telecommuting from a center.

Monetary incentives were offered to motivate the completion of attitudinal surveys and travel diaries. The primary incentive was a drawing for cash prizes of $100, $150, and $250. Two drawings were held: one in December 1994 for before survey instruments and one in July 1995 for after survey instruments. Each attitudinal survey or travel diary returned by a telecenter user, a control group member, or a household member counted as one entry in the drawing. Later in the evaluation process, when recruiting control group members proved difficult, an incentive of five dollars per completed survey was offered to those groups. This stimulated participation somewhat, but control group sample sizes remain substantially smaller than those for center-based telecommuters.

Table 1-1: Evaluation Plan

a. Before Telecenter Use

Study Group	Attitudinal Survey (once)	Travel Diary (3 consecutive days)
Center-based telecommuters	Employee & Manager	Employee & Household
Home-based telecommuters	Employee & Manager	Employee & Household
Non-telecommuters	Employee & Manager	Employee & Household

b. After Telecenter Use

Study Group	Attitudinal Survey (once)	Travel Diary (3 consec. days)	Attendance Log (continuously)	Exit Interview (when necessary)
Center-based telecommuters	Employee & Manager	Employee & Household	Employee	Employee
Home-based telecommuters	Employee & Manager	Employee & Household	---	---
Non-telecommuters	Employee & Manager	Employee & Household	---	---

The attitudinal survey is a sixteen-page questionnaire that asks about participant characteristics and their attitudes toward telecommuting. Prior to the commencement of telecommuting from the center, the prospective telecenter user completed the before-wave version of the attitudinal survey. Approximately six months after the start of telecenter use, the center-based telecommuters were again surveyed (a copy of the "after" survey is included as Appendix E). Although the after-wave version of the attitudinal survey contained some new questions about experiences at the telecommuting center, most questions remained the same as in the initial version. Consequently, comparisons between the two survey waves can be used to show changes in attitudes related to work and telecommuting. However, any measured changes are not necessarily caused by telecommuting from a center, but they may in fact be due to other events independent of this project. As a hypothetical example, a negative change in attitudes toward work and productivity may be caused by the downsizing of certain organizations rather than by the ineffectiveness of telecommuting.

To control for these potential background changes, two comparison groups, home-based telecommuters and non-telecommuters, were identified. The control group members (up to six from each of the two groups per telecenter user) were recruited from the same organization and

chosen to have a position similar to that of the telecenter user, where possible. While the attitudinal survey was modified somewhat to account for the differences among the three study groups, the majority of the questions are identical or have a parallel structure in order to facilitate the comparison of responses. For the most part, the home-based and non-telecommuters were surveyed at approximately the same time as their associated telecenter user for both administration waves. The data from the control group members provide information on background effects in the workplace. Thus, the changes observed in the telecenter users are controlled for, allowing the identification of the effects related to telecommuting center use. Additionally, the home-based telecommuting group provides the opportunity to distinguish attitudes and impacts common to both forms of telecommuting from those specific to the center-based form.

In addition to the survey of telecommuting employees, a parallel attitudinal survey was developed to measure manager characteristics and perceptions. This twelve-page survey was administered to the manager of each prospective telecenter user and control group member before the start of telecenter use. The managers were again surveyed in the after wave (a copy of the survey is included as Appendix F). A description of the contents and results of the employee and manager surveys for the telecenter users can be found in Chapter 3 of this report. The surveys of control group employees and managers will be analyzed later, as resources permit.

The travel diary was used to record the transportation activities of study group employees and their household members during three consecutive days (a copy of key elements of the diary is provided in Appendix H). All three study groups were included in the sample studied using the travel diary. The home-based and non-telecommuter households serve both as controls for background effects and as comparisons to the travel activities of center-based telecommuter households. The travel diary was also administered in two survey waves, before and approximately six months after telecenter use began. There were no day-of-the-week restrictions for the control groups or for the prospective telecenter users on the before travel diary. However, on the after diary the telecenter users were requested to include at least one telecenter use in their three-day period. The discussion of the travel diary results in Chapter 6 is restricted to the after wave for telecenter users only and focuses primarily on the differences in travel on days they worked from the telecenter versus days they did not work from the telecenter.

The sign-in logs captured the use of the telecommuting centers on a daily basis. For each telecommuting occasion, project participants were asked to sign an attendance log to record their presence. Besides their name, telecenter users were also asked to give the time spent at different work locations and the means of travel to the center (a copy of the sign-in log is provided in Appendix G). The data from the sign in sheets provide a measure of telecommuting frequency, center occupancy, and travel behavior. Chapter 4 covers the tabulation and analysis of the attendance log data.

Finally, those who quit telecommuting from a center were given an exit interview to determine the reason(s) for leaving. The administration of an exit interview is prompted by one of two occurrences. In some cases, participants informed their site administrator of their intention to quit. Other participants were contacted about their project status if they had failed to sign the attendance log for an extended period. The interview itself asks primarily about the motivation for quitting and the current preferences for work locations. Descriptions of the responses to the exit interviews are given in Chapter 5.

1.3 Report Outline

This report is organized into seven chapters. Following the introduction, some procedural issues involved in conducting the evaluation of telecenter impacts are discussed. The third chapter describes the results of the attitudinal and demographic surveys administered to the telecenter users and their managers. In Chapter 4, the patterns of telecommuting use are examined by site and by individual. Next, factors in the retention of center-based telecommuters are addressed. The sixth chapter investigates the travel impacts of telecenter use by comparing telecommuting to non-telecommuting days. The conclusion summarizes the major findings at this point in the evaluation process and outlines further analyses of the data that could be performed.

CHAPTER 2

PROCEDURAL ISSUES IN THE EVALUATION PROCESS

2. PROCEDURAL ISSUES IN THE EVALUATION PROCESS

2.1 Administration of the Project Evaluation

Although the focus of the Residential Area-Based Offices (RABO) Project is to investigate the organizational acceptability and travel impacts of telecommuting centers, some interesting lessons were learned about the project evaluation process. Measurement of telecenter operation, as required by the project, necessitates constant communication with site administrators, who provide information on the status of project participants. As a result, a member of the evaluation team (referred to here as the Evaluation Manager) was assigned to keep in contact with the site administrators to monitor the progress of telecenter use. The duties of the Evaluation Manager included tracking the status of telecommuters, providing survey materials to the sites, collecting returned survey materials, and conducting exit interviews by phone.

A number of issues arose in the process of conducting the evaluation of the RABO Project, and these issues are described more fully in the later sections of this chapter. These issues included both policy decisions as well as unforeseen events that increased the effort required to conduct the evaluation properly. These issues of evaluation procedure can be divided into compliance with contractual obligations (Section 2.2), measurement of site usage (Section 2.3), and modifications to the survey process (Section 2.4).

2.2 Contract Administration

As part of the RABO Project, the university sought applications from developers interested in establishing telecommuting centers. The site developers were required to sign contracts with the university which had provisions requiring the implementation of telecenters and the collection of data from the telecenter users. In addition, site developers were required to have employers interested in utilizing the center sign a memorandum of understanding (MOU) that described telecenter procedures and the evaluation requirements of the university (see Appendix I). Unfortunately, problems arose with the collection of data from project participants that necessitated changes to the site developer contracts. These problems included indirect contractual arrangements, insufficient motivation for users to participate in the evaluation, and inefficient survey administration.

2.2.1 Contractual Arrangements

For some site developers, contractual arrangements hampered the communication link between the evaluation team and the site administrator. Lower-level subcontractors and independently established telecenters were not tied to the evaluation as closely as the majority of the centers, and as a result, data collection from these sites was adversely affected.

In one particular case, a site developer, who was subcontracted under the RABO Project to open and operate a telecommuting center, subcontracted, in turn, with a private company to manage the site. The lack of direct leverage with the company managing the center and interacting with the telecommuters made the evaluation process more difficult. Several months passed before the private firm responded to the data collection needs of the project. Consequently, the baseline surveys were administered after telecommuting had begun (instead of prior to the start of

telecommuting) which resulted in poor quality data. For future projects, it is recommended that the contractual relationship be directly with the entity managing the site and performing the evaluation services. Where this is not possible, special contract provisions need to be made to ensure proper compliance with evaluation procedures.

As part of the RABO Project, five telecommuting centers were included in the evaluation that were established outside of the project (see Table 2-1). While three of the five centers also received funding from the California Department of Transportation (Caltrans), they received no direct funding from the RABO Project. The other two sites, Concord and San Jose, were evaluated under an MOU between Caltrans and the Metropolitan Transportation Commission, but yielded very little usable data. As above, all of these sites had no direct contractual relationship with the university and, therefore, lacked an immediate incentive to provide data. It was not until Caltrans used its funding leverage that cooperation from the non-RABO sites was obtained.

Table 2-1: Telecenters Monitored in the Evaluation (status as of June 30, 1995)

a. RABO Sites

Site	Opening Date[1]	Closing Date	Site	Opening Date[1]	Closing Date
Roseville[2]	9 / 93	N / A	Vacaville - Ulatis	8 / 94	---
Coronado	11 / 93	---	Chula Vista - H St.	9 / 94	---
Grass Valley	2 / 94	---	Modesto	10 / 94	---
Auburn[2]	3 / 94	N / A	Chula Vista - F St.	11 / 94	---
Citrus Heights[2]	3 / 94	N / A	Ventura	2 / 95	---
Anaheim[2]	6 / 94	---	La Mesa	3 / 95	---
Davis[2]	8 / 94	---	Moorpark	4 / 95	---
Vacaville - Alamo	8 / 94	---			

b. Non-RABO Sites

Site	Opening Date[1]	Closing Date	Site	Opening Date[1]	Closing Date
Ontario	11 / 91	---	Concord	9 / 93	2 / 94
Highland	12 / 92	---	San Jose	9 / 93	2 / 94
Antelope Valley Fair	7 / 94	---			

[1] The opening date corresponds to either the date of the first telecommuting occasion or the official opening date if sign-in data from the center is not available.

[2] These sites left the RABO project before June 30, 1995.

Even after cooperation of the sites was assured, the telecommuters themselves were not always willing to participate in the evaluation. Unlike the RABO sites, the center users at non-RABO sites did not sign any type of MOU. Thus, survey completion was not a requirement for telecenter use. While the non-RABO sites have been included in the analysis in this report to the extent possible, the quality of the data collected and the response rate of the telecommuters is poorer than that for the RABO sites.

2.2.2 Ensuring Compliance

Even with a direct link established between the Evaluation Manager and the site administrator, problems arose in the measurement of center activity. Although all but one developer included a provision in their MOU specifying user participation in the evaluation process, at least two developers described this process as "voluntary". This was, in part, a reflection of a faulty understanding of university policy regarding the use of human subjects in behavioral studies, and in part, an attempt on the part of the developer to secure as many users as possible by minimizing program requirements. Developers were concerned that too rigorous an application of evaluation requirements would further jeopardize the already-difficult marketing situation: employers could perceive the evaluation process as overly burdensome and refuse to use the center altogether. As a result, telecenter users and their managers who were originally unaware of the need to complete surveys were less willing to participate in the evaluation in exchange for their use of the telecommuting center. Since compliance with the evaluation process relied only on the goodwill of the participants to return their surveys and travel diaries, the response rate was much less than one hundred percent.

In an effort to address this problem, the university policy regarding behavioral studies was re-examined. State law requires that participation in studies such as the RABO Project must be voluntary. After consulting with the university's Human Subjects Review Committee, the evaluation team determined that while participation in the project is voluntary, once signed up for the project, the completion of survey materials could be made mandatory in order to remain a participant. Hence, for telecenter users and their managers, references describing the completion of surveys as voluntary was removed from survey cover letters and other materials. Those references were retained for the home-based telecommuter and non-telecommuter groups.

The decision to exclude participants based on failure to complete surveys prompted a number of changes to the project evaluation. Perhaps most importantly, the funding of telecenter sites was linked to survey response rate. One provision of an amendment to the project contract stated that if a survey were more than 30 days delinquent, the participant would no longer be counted in the center's occupancy rate in terms of contract compliance (attendance and other evaluation data already collected were retained and analyzed for such a participant, however). The telecenter would not be able to recover the money even if the surveys were received at a later date. After the implementation of this provision, a regular procedure was set up whereby site administrators would be informed on a bimonthly basis of outstanding survey instruments.

2.2.3 Survey Administration

Originally, the site administrator at each center was to handle the distribution and collection of survey materials provided by the Evaluation Manager. The rationale behind having the center as intermediary is ease of contact for the participating employees. With the start of

telecommuting, it soon proved difficult to track the distribution of survey materials by the site administrators. Much of this problem was due to the turnover among site personnel that many sites experienced (while some site administrators were temporary employees only, other site personnel left due to low pay for the work involved and/or inadequate job performance). Replacement administrators often received little, if any, training from the site developer. Much time was spent by the evaluation staff in acquainting the new site administrators with the evaluation process. Occasionally, materials and valuable data were lost due to an inexperienced administrator.

In an attempt to solve the problems with survey administration, site administrators were offered the option of distributing materials themselves or allowing the Evaluation Manager to handle the process directly. Although the latter method makes it more difficult for participants to return materials or ask questions, the surveys are much more likely to be distributed and collected efficiently. Meanwhile, a form for all sites was developed to help the Evaluation Manager keep track of new telecommuters. For the sites that continued to administer the surveys directly, the new form ensured that the evaluation team was aware that surveys were being distributed. In the cases where the Evaluation Manager handled the process (which happened at a majority of the sites), the tracking data provided the information needed to distribute survey materials.

2.3 Measuring Site Occupancy and Usage

In order to measure the use of telecommuting centers for both funding and evaluation purposes, certain criteria were developed. The analysis presented in this report distinguishes between site occupancy and site usage. The formula for the monthly *site occupancy rate* is the number of telecommuting occasions by registered telecommuters that lasted *at least four hours* divided by the product of the number of workstations and the number of work days in the month. The monthly *site usage rate* is similar but considers the number of all telecommuting occasions of any length in the calculation, instead (see Section 4.3.1).

Compliance with contractually-set occupancy targets was based on the occupancy rate rather than the usage rate. The criterion for the time spent at the center was arbitrarily set at four hours in an attempt to screen out occasions where the user spent most of the day at the regular workplace. If the telecommuter visits both the center and the main office on the same day, there would be no reduction in vehicle-miles traveled (VMT) for that telecommuting occasion. Nevertheless, it is important to see how usage of the center evolves naturally. If the telecenter is most often utilized on a part-time basis, either on the way to or from work locations or as an occasional supplement to home-based telecommuting, that knowledge would affect how the center is operated, priced, and marketed. Accordingly, both site usage and occupancy rates are analyzed in the evaluation presented in Chapter 4.

However, in one special case, telecommuting occasions of less than four hours were included in the site occupancy rate. Some telecenter users with field jobs found it more convenient to use either of two centers in the area depending on which was closer to the field location. In some cases, the total telecommuting time at both centers may have exceeded four hours on a given day. More importantly, these participants were working at the telecenter instead of returning to the regular workplace to complete paperwork. Therefore, they reduced their daily VMT and for this reason are included in the occupancy rate.

In fact, the centers were utilized in many ways that fell outside the strict definition of telecommuting, some of which had potentially important travel-reduction benefits. Uses that were not formally evaluated included drop-in use by non-participants and leasing of space to large companies. Although some sites excluded those who would have used the telecenter as a primary place of business for small businesses, other sites allowed these workers to work from their centers. Videoconferencing, a non-telecommuting use that was formally tracked, is discussed in Section 2.4.2.

2.3.1 Drop-in Use and Single-company Leasing

In order to bring in additional revenue, all telecenters experimented with drop-in programs. Drop-in use allows customers to walk into the center and rent a workstation for their use. These telecenter users are not participants in the RABO Project since they do not sign a MOU or complete any surveys, and therefore, they are not counted as part of the occupancy rate. Of course, the registered telecommuters have priority for use of the workstations. However, conflicts between project participants and drop-in users were rarely a problem because most centers had unoccupied workstations.

In addition to drop-in programs, some telecenters leased workstations to companies looking for supplemental office space. Since the company itself was in charge of the use of the space, it was unclear whether the workstations would be used for telecommuting or as a branch office (in fact, some of the rented center space was used as classrooms and teaching facilities). Consequently, these tenants were not required to participate in the evaluation and also not counted in the occupancy rate. Although these participants were not involved in the evaluation, some centers measured the travel by the employees of these companies and found significant savings.

2.3.2 Telecenter as a Primary Place of Business

Defining a true telecommuter for the purpose of this study proved to be difficult because many different types of employees used the centers. Additionally, telecommuting centers used different criteria for the admission of prospective telecenter users. While some telecenter users were employees at a large firm who had a main office elsewhere, others were self-employed or employees of small businesses and used the telecenter as their primary place of business. Both non-RABO and RABO sites had telecommuters who fell into the latter category of telecenter users, some of whom were included in the evaluation process. Importantly, small business employees have an advantage for the evaluation program in comparison to large company employees. Small businesses have fewer layers of authority to go through, so it is usually easier to obtain participation in the telecommuting study. The desire to fill telecommuting centers will likely lead to more participation by these types of employees. However, the use of the telecommuting center as a primary place of business has some negative effects on the evaluation process which are further discussed below.

First of all, small business workers may have trouble complying with all elements in the survey process. While some small business employees have a manager, sole proprietors or independent contractors do not, by definition. Additionally, these workers may lack any co-workers or may have only a few. Both manager and co-worker surveys are part of the evaluation process. Using small business employees reduces the size of these comparison groups.

Secondly, one of the goals of the RABO Project was to demonstrate the advantages of an alternative work location for employees who would otherwise have no choice over their work location. Sole proprietors already have the choice to work at whatever location best suits them. For small businesses that use the center as a primary place of business, the employees do not have any other alternative besides the center. Thus, in these cases, the advantages of alternative work locations cannot be evaluated.

Thirdly, the transportation benefits of those who use the telecenter as the primary place of business are indeterminate. For other employees, it is easy to see that travel is reduced if the commute trip is longer to the regular workplace than to the center (assuming that only one commute trip is made that day). But for small business workers, it is not clear what the alternative work location is. There may be no alternative location, or the alternative location may be home, in which case travel is generated, not reduced.

Finally, equity issues are also a concern for small business participation in the telecenter study. As part of the RABO Project, telecommuters are typically provided with workstations at below-market rates in order to stimulate interest in the concept. As a result, sole proprietors and small businesses who do not have an office other than the center could be unfairly subsidized in relation to their competitors who must pay full value for work space. Nevertheless, some level of experimentation is appropriate for a demonstration project, and it may be expected that a rent subsidy would not continue indefinitely for any user.

Despite the problems with those who use the center as a primary place of business, the complete exclusion of these users is not recommended. In fact, they may ensure stability for center operation and, therefore, be a key factor in the long-run success of the telecommuting center concept. A diversity of users and uses appears to be a critical element in the success of telecenters (Bagley, *et al.*, 1994). However, in order to control for the negative effects on the evaluation process, the following recommendations are suggested for future demonstration projects of this nature. First, since these users cannot provide the full data requirements and have no demonstrable transportation benefits, the proportion of workers of this type should be limited (for example, a limit of 25% of occupied workspace-days). Second, site developers should charge the businesses using the center as a primary workplace the full-market rent in order to prevent inequitable subsidization of these businesses.

2.4 Changes to the Survey Process

Although the survey process as described in Section 1.2 generally follows the original evaluation plan, some modifications were made during the course of the RABO Project evaluation. The two most important changes are discussed in this section. Perhaps the most obvious change is the removal of focus groups from the evaluation plan (Section 2.4.1). Also, a survey was developed to measure the use of videoconference equipment that was available at some centers (Section 2.4.2). These changes and the reasons for them are further discussed below.

2.4.1 Focus Groups

Originally, focus groups were slated to be held in order to identify problems in the early stages of telecenter use. For all sites, both telecenter users and their managers would have had a separate session to discuss early experiences with the telecommuting center concept and any

difficulties they might be having. Once the problems were exposed, they could be effectively addressed by the university and the site developer. Although focus groups have been used effectively in evaluating home-based telecommuting programs, there are some important differences that hindered their use in the RABO Project.

The first key difference is timing the start of telecommuting. In previous studies at a single organization, telecommuting was scheduled to begin for all participants at roughly the same time. Thus, the participants experienced the same problems together. For the RABO Project, the entry of participants into the program is staggered according to when each signs up. So, if focus groups were held too soon after a center opens, there would not be enough participants. On the other hand, waiting too long after the start of telecommuting may let problems remain unsolved, thereby damaging the telecommuting experience.

The other important change from previous telecommuting projects involves the scheduling of the focus groups. In the previous programs, managers and telecommuters usually participated in separate but consecutive sessions held at the work site during normal business hours. In the case of telecommuting centers, multiple employers are involved which makes it difficult to identify a suitable time and place. Although the telecenter may be a natural location for the employees, work schedules are likely to differ considerably: not everyone telecommutes on common days. For the managers, the somewhat remotely located center is probably not ideal, and scheduling the time of the meeting is likely to be at least as difficult as for the employees.

Due to the problems with timing and scheduling, the alternatives for exposing early problems were investigated. Although professionally-conducted focus groups are costly in terms of money and time, they provide impartial moderators and foster a certain synergy through the group discussion. Telephone interviews conducted by the university are less impartial but are more affordable and allow for asynchronous administration, such that everyone would not need to be in the same place at the same time. Non-aggressive monitoring would let minor problems be resolved at the site level and have only major problems reported to the university. The drawback here is that certain problems may go unreported without direct contact with the telecenter users. Finally, although complete site administrator monitoring would allow for personalized contact, the impartiality of the site personnel is compromised since they may be part of the problem.

After careful consideration, the final decision was to have the Evaluation Manager conduct non-aggressive monitoring by contacting project participants three months after telecommuting began in order to discover any difficulties they might be having. It was felt that since the Evaluation Manager had established contact with most of the participants and was seen as a neutral party, this method of contact would provide the most effective responses.

2.4.2 Videoconference Use

A number of the telecommuting centers provided videoconference rooms to both project participants and outside users as part of their facilities. Since the use of videoconferencing equipment has the potential to reduce the travel required to attend meetings, a survey form was developed to measure the impacts of each use. The form was designed to track the usage of the facility and includes blanks for the names of those attending, the location of other sites participating in the meeting, the reasons behind selecting videoconference technology, and the most likely alternative to the videoconference. Since the survey was developed midway through

the evaluation process, results are not yet available for this interim report. The results of the videoconference usage form, however, will be included in the final report.

2.5 *Summary of Procedural Issues*

The RABO Project not only provides information on the practice of telecommuting center use, it also provides valuable lessons in the process of evaluating the use of telecommuting centers. The procedural issues related in this chapter dealt with contractual compliance, site usage measurement, and modification of the survey process. Since telecommuting centers are a relatively new concept, the lessons learned here will help later evaluation programs be more effective.

Changes to the contracts with site developers were necessitated by problems with data collection. Some contracts did not directly tie the university to the administrators of the telecenter which resulted in poor communication and inadequate survey response rates. At all centers, survey response rates that were lower than desired led to modifications of the center funding policies. Telecommuters were only counted in funding invoices if they had completed the required surveys. This new policy also emphasized that, while participation itself was voluntary, survey completion was a mandatory element of participation. Additional methods for improving survey collection included shifting the duties of survey distribution and collection from the site administrator to the Evaluation Manager for those centers who did not want to handle these activities.

A strict definition of telecenter occupancy was developed to ensure that the measured rate of telecommuting reflected the goals of the study. The monthly site occupancy rate calculated to assess compliance with contractual targets includes only the telecommuting occasions by project participants that lasted at least four hours. However, there were other meaningful (in terms of travel reduction) uses of the center that fell outside this narrow definition. As a result, uses by telecommuters for any length of time were documented and evaluated. Further, most sites set up at least some of their workstations for use by drop-in customers, and others specifically leased work space to particular companies (neither of those types of center users participated in the evaluation). Some participants who use the center as their primary place of business were included as project participants even though their situation is quite different from the typical telecommuter from a large organization. These participants may not have managers or co-workers to participate in surveys, may not have travel reduction benefits, and during the demonstration period, may be unfairly subsidized in relation to other similar businesses in terms of office space costs. It is recommended that a screening process be used to give highest priority to those who are truly telecommuting while still allowing other uses to continue at the site since a diversity of clients is a key to long-term operation.

Other issues involved in the evaluation process included changes to the survey procedure. Originally, focus groups were to be used to identify any initial problems and concerns of both the telecommuters and their managers with the use of telecommuting centers. However, problems with timing and scheduling caused the focus groups to be dropped in favor of individual telephone interviews. Additionally, the availability of a videoconferencing room at some telecommuting centers led to the development of a usage log for these facilities. The information collected from the videoconference logs will be summarized for the final report.

CHAPTER 3

ATTITUDINAL SURVEY ANALYSIS

3. ATTITUDINAL SURVEY ANALYSIS

3.1 Quasi-Experimental Design Structure

The data collection process was designed to make comparisons along three dimensions. First of all, both employees and their managers were polled on their attitudes about telecommuting. Both surveys focus on job performance and satisfaction of the employee, perceptions of telecommuting, and feasibility of telecommuting for the employee. Identical or parallel wording was used between employee and manager surveys to the extent possible. The manager surveys also include a section on the organization's opinions about telecommuting.

Three study groups make up the second survey dimension: center-based telecommuters, home-based telecommuters, and non-telecommuters. The center-based telecommuters surveyed in this study come both from the RABO telecenters and from two southern California non-RABO telecenters which the university was contracted to evaluate. Members of the other two groups (including both employees and their managers) were recruited from the same organizations through the telecenter users or their employers and were chosen, where possible, to have a position similar to that of the telecenter user or the user's manager, respectively. The control groups were included to see how center-based telecommuting differed from more familiar work arrangements. Where changes in attitude and behavior over time are noted in the telecenter group, the control groups help to determine whether those changes are a result of telecommuting from a center, common to telecommuting in general, or a consequence of background changes affecting all workers. Thus, the control group surveys were designed to parallel the telecenter group surveys as closely as possible, with the obvious exception that the latter surveys contained some questions about the telecenter experience that were not applicable to the other groups.

Finally, the surveys were administered in two waves. In the first wave, the prospective telecenter user and the associated study group employees and managers were to be given surveys before telecommuting from the center began. Although this was the ideal situation, in some cases the surveys did not reach the respondents until soon after center use had already begun. Starting in April 1995, the second wave of surveys was distributed (5 to 18 months after the before surveys, an average of 9.0 months) in order to obtain opinions after familiarity with center-based telecommuting had been achieved. The two survey waves allow for an analysis of how perceptions of center-based telecommuting change with actual experience since the before wave benchmarks job satisfaction and performance levels. Although some modifications were made between the before and after versions, the surveys are primarily the same containing many identically worded questions.

The data tabulated in this interim report comes from a subset of the total surveys returned. To allow sufficient time for after data collection, analysis, and reporting, only those respondents who returned their initial surveys before December 5, 1994, are included in this analysis. The second wave surveys were mailed to telecenter users who had spent at least five months as project participants and to the associated study group members. For this report, the cutoff date for after survey data entry was July 21, 1995. Thus, the before surveys were completed during the period from July 1993 to December 1994, and the after surveys from April through July 1995. For both waves, approximately one-fourth of the data comes from non-RABO sites.

The number of surveys received in each of the categories is shown in Table 3-1. Additional before and after surveys have been received since the cutoff dates by both existing and new participants associated with both existing and newly opened telecenters. This additional data will be analyzed in conjunction with the final report.

Table 3-1: Number of Surveys Received (Pre-12/5/94 Sample)

Type	Wave	Study Group			Total
		Center-based Telecommuters	Home-based Telecommuters	Non-telecommuters	
Employees	Before	61	15	21	97
	After	39	11	17	67
Managers	Before	33	10	6	49
	After	28	4	2	34

This interim report focuses on the attitudinal surveys for telecenter users and their managers, only (see Appendices E and F). Comparisons to the other study groups will be conducted in the future as resources permit. Key findings for the employee telecenter user surveys are discussed in Section 3.2, which describes the characteristics of the telecenter users and compares certain characteristics before and after the beginning of telecommuting. Later on in the report, Section 5.2 presents a comparison of the traits of those that continued to telecommute from a center with those who dropped out of the program. Section 3.3 covers the surveys for managers of telecenter users. Finally, the responses of employees and managers are compared and contrasted in Section 3.4.

3.2 Employee Survey Results

Unless otherwise specified, the findings reported below come from the 39 after surveys (see Appendix E) returned by the center-based telecommuters (see Table 3-1). Where changes over time are of particular interest, before and after responses are compared for the 27 respondents who have completed both versions of the telecenter user survey.

Due to overlapping survey distribution and data entry cutoff dates, the total response rate for either the before or after surveys is too complex to determine easily at this point in the evaluation. However, for the pre-12/5/94 sample, 27 of the 39 respondents to the after survey also completed the before survey (the remaining twelve surveys came from non-RABO respondents who were telecommuting from a center prior to the start of the RABO project). Thus, one can calculate a response rate that measures the number of surveys received from those who were eligible to receive the after surveys. Of the 61 before surveys received, 30 respondents had quit before the after surveys were distributed in April 1995. As a result, the after survey response rate for participants who also submitted a before survey is equal to 27 divided by 31 (61 - 30), or 87.1%.

The employee surveys contain six sections: job characteristics, job performance and satisfaction, work environment characteristics, the amount of telecommuting, travel characteristics, and demographic information. Findings from each of these sections are discussed below, although in a different order from their appearance in the survey. In particular, demographic information is presented first in order to characterize the nature of the sample.

3.2.1 Demographic Characteristics

Since the survey was designed to be administered to the same people in both waves, demographic information that was not expected to change was obtained only on the initial survey. As a result, the characterization of the after data set in terms of gender and age is restricted to the 27 respondents who returned both surveys. (Demographic data are now being collected for those who have only completed the after surveys, thus augmenting the information that will be analyzed in the final report). The sample population has more females, 16 (59.3%), than males, 11 (40.7%). Nearly half the sample falls into the median age category of 35 to 44 years of age (48.1%). The adjacent categories, from 25 to 34 and from 45 to 54 years of age, are the next largest at 22.2% each. The remainder, 7.4%, goes to the next highest category, 55 to 64 years of age (see Table 3-2).

Table 3-2: Employee Demographic Characteristics

Characteristic	Number (Proportion)	Characteristic	Mean (Std. Dev.)
Female[1]	16 (59.3%)	Household size	2.97 (1.33)
Age 25 to 34 years[1]	6 (22.2%)	Full-time workers	1.54 (0.64)
Age 35 to 44 years[1]	13 (48.1%)	Part-time workers	0.15 (0.37)
Age 45 to 54 years[1]	6 (22.2%)	Vehicles per household	2.29 (1.13)
Age 55 to 64 years[1]	2 (7.4%)	Vehicles per worker	1.38 (0.51)
Dependent care	2 (5.1%)	Vehicles per licensed driver	1.13 (0.33)
Children less than 6	13 (33.3%)	Licensed drivers per household	2.00 (0.65)
Children less than 16	21 (53.8%)		

[1] N = 27

In the full data set (39 respondents), the average household size was 3.0 persons. Only two persons (5.1%) of those sampled had a household member who needed special care. One-third have children under the age of six, and more than half (53.8%) have children under the age of 16. Each household had, on average, 1.5 full-time and 0.2 part-time workers. Between the survey administrations (based on the reduced sample size of 27), the number of full-time workers increased slightly (from 1.4 to 1.5), and the number of part-time workers fell slightly (from 0.3 to 0.2). No one in the sample is without a driver's license. There are 2.0 licensed drivers per

household and 2.3 vehicles available to the household for trips. Finally, there are 1.1 vehicles per licensed driver.

The respondents on the whole were very well educated. Again using the reduced data set, forty-four percent held only college degrees, an additional 7.4% had taken some graduate school, and another 22.2% had completed at least one graduate degree (see Table 3-3). Of the remaining respondents, most had some college education (18.5%), and only 7.4% had simply a high school diploma.

The data from the after surveys show that annual household income before taxes is skewed towards the higher categories (see Table 3-3). The most frequent annual household income bracket is $75,000 or more (43.6%). The next two categories, $35,000 to $54,999 and $55,000 to $74,999, each have 25.6% of the sample. The remaining 5.1% earned between $25,000 and $34,999 per year.

Table 3-3: Employee Education and Household Income

Education Category (N = 27)	Number (Proportion)	Household Income (N = 39)	Number (Proportion)
High school graduate	2 (7.4%)	Less than $25,000	0
Some college	5 (18.5%)	$25,000 to $34,999	2 (5.1%)
College degree	12 (44.4%)	$35,000 to $54,999	10 (25.6%)
Some graduate school	2 (7.4%)	$55,000 to $74,999	10 (25.6%)
Graduate degree	6 (22.2%)	$75,000 or more	17 (43.6%)

3.2.2 Job Characteristics

The first section of the survey asks questions about the type of work the respondent does (see Table 3-4). Returning to the full after data set, the majority of the sample (53.8%) classified their current position as professional/technical. The other categories are manager/administrator (23.1%), sales/marketing (12.8%), and administrative support (10.3%). Although there is a wide range in responses, respondents had worked for their immediate supervisor for 3.1 years on average, for their present employer for 8.2 years, and in their present occupation for 10.2 years. The respondents reported working an average of 83.2 hours in a two-week period.

The respondents worked under a variety of work schedules (see Table 3-5). The two top categories are variable flextime (38.5%) and fixed flextime (25.6%), with the conventional schedule (15.4%) coming in at a distant third. Additionally, there were some workers on a compressed work week (15.4%) and some working part-time (5.1%).

Table 3-4: Employee Job Type and Work Duration (N = 39)

Job Type	Number (Proportion)	Work Duration	Mean (Std. Dev.)
Manager / Administrator	9 (23.1%)	Years worked for supervisor[1]	3.12 (3.02)
Professional / Technical	21 (53.8%)	Years worked for employer[2]	8.21 (6.53)
Administrative support	4 (10.3%)	Years worked in occupation	10.23 (6.80)
Sales / Marketing	5 (12.8%)	Hours worked in two weeks	83.23 (10.97)

[1] N = 36 [2] N = 37

Table 3-5: Employee Work Schedule (Number and Proportion)

Work Schedule	Reduced (N = 27)		Full (N = 39)
	Before	After	After
Part-time	4 (14.8%)	2 (7.4%)	2 (5.1%)
Conventional	3 (11.1%)	6 (22.2%)	6 (15.4%)
Fixed flextime	9 (33.3%)	7 (25.9%)	10 (25.6%)
Variable flextime	8 (29.6%)	10 (37.0%)	15 (38.5%)
Compressed work week	3 (11.1%)	2 (7.4%)	6 (15.4%)

It is of interest to analyze the impact of telecommuting on the type of work schedule. One might expect more flexible schedules to become more popular with the use of telecommuting centers. However, in some programs, employees have been required to choose between telecommuting and other forms of flexible work which suggests that an increase in telecommuting may result in a decrease in other flexible schedules. The reduced data set shows that respondents did change their work schedules between survey measurements. The number of part-time and fixed flextime workers dropped slightly (by 2 respondents each), while the number of conventional and variable flextime workers went up (by 3 and 2 respondents, respectively). The data show that both less flexible and more flexible schedules increased, thus supporting the hypothesis that either effect could be expected.

The survey asked each respondent to classify the time spent on the job into five activity categories (see Table 3-6). Respondents reported that they spent approximately 47% of their time working independently. They split the time working with others evenly (about 18% each) into face-to-face and remote communication. Work at a specific location (9.2%) and work-related travel (6.8%) accounted for the rest of the work day. Although there may be variations at the individual level, the two sets of responses for the 27 who answered both survey versions shows that the aggregate percentages remain essentially the same between the two survey waves.

Table 3-6: Employee Work Activity Proportions (Mean and Standard Deviation)

Work Activity	Reduced (N = 27)		Full (N = 39)
	Before	After	After
Independent	45.5% (27.2)	48.7% (26.2)	47.4% (26.4)
Face-to-face	17.5% (8.7)	16.5% (9.6)	19.1% (12.1)
Remote	18.1% (15.6)	17.8% (19.6)	17.5% (17.7)
At a specific location	7.8% (12.3)	9.3% (9.6)	9.2% (9.6)
Travel	10.7% (14.6)	7.8% (10.2)	6.8% (9.0)
Other	0.4% (1.9)	0%	0%

3.2.3 Job Performance and Satisfaction

Respondents were asked a number of questions on their perceptions regarding their job, the first of which asks the respondent to rate his/her job performance according to four aspects. The averages for the four aspects all fall near 4.0 (that is, "good") on a five point scale. The telecenter users rated their amount of work done as 4.26, work quality as 4.44, ability to meet deadlines as 4.18, and productivity as 4.36 (see Table A-1, Appendix A). The balanced data set shows minimal change between before and after measurements, indicating that telecommuting did not significantly affect the respondents' opinions of their work performance (see Table B-2, Appendix B). However, all questions except the ability to meet deadlines were rated slightly higher on the later survey.

The second question asks respondents how their supervisor would rate them on the same four work aspects. The average scores are very similar to the first question with only the quality of work being slightly lower at 4.32 (see Table A-1, Appendix A). The later measurement for the reduced data set shows that the respondents thought their supervisor would rate them slightly lower on the four aspects after using the telecenter. However, only for the ability to meet deadlines is the decrease significant according to a t-test of the means (see Table B-2, Appendix B).

The final section asks the respondent to give an opinion on various job satisfaction components, again on a five-point scale. Looking at all the questions in order, the following observations may be made (although there were both positively- and negatively-oriented questions, the average scores reported below have all been changed to positive orientation, see Table A-1, Appendix A). On average, respondents feel they communicate well with their supervisor (4.2), have a good opportunity for promotion (3.6), have sufficient resources to do the job (3.5), are part of an effective work team (3.9), and work well with their supervisor (4.1). Most respondents found their job to be not tedious or boring (4.3), working gave them a sense of accomplishment (4.0), and they had appreciative supervisors (4.1). The telecenter users also were very confident of their work ability (4.5), got along very well with their co-workers (4.5), and were unlikely to look for a new job (3.8). Overall, the sample members who had clients (38%) are not particularly

bothered by their demands (3.5). Of the 24 respondents who supervised other employees (62%), most worked well with them (3.9). The average response for overall satisfaction was 4.1. The average responses from the before and after surveys for the balanced data set show much variation, but none of the changes are statistically significant (see Table B-2, Appendix B).

3.2.4 Work Environment Characteristics

The questions in the third section of the survey ask about the respondent's attitudes toward characteristics of the work environment at three different work locations (see Table A-2, Appendix A). Similarly to the job satisfaction questions, t-tests were conducted for the responses to the work characteristic questions to look for significant differences between the before and after surveys on the reduced data set (see Table B-3, Appendix B). Very few of the averages changed significantly after telecommuting from the center began. However, distractions from others were more of a problem at the telecenter than originally envisioned (from a mean of 1.81 to 2.37, at a p-value of 0.029).

For the full after data set, the means for each question are graphed according to each of the three workplaces (regular workplace, telecommuting center, and home) in Figure A-1 of Appendix A. A one-way analysis of variance was conducted for each question to test for significantly differing means among workplaces. All questions except two show significant differences among workplaces (see Table A-3, Appendix A). Having work judged by the results and communication with the supervisor were unaffected by a change in workplace location.

On the before survey, a section was included where respondents were asked to rate the importance of the same work environment characteristics on a four-point scale (see Table A-4, Appendix A). Using the balanced data set, the characteristics that have the highest and lowest average importance rankings overall are shown in Tables 3-7 and 3-8 respectively. The prospective telecenter users feel that working effectively, having the needed equipment, and having their work judged by its results were very important. They also rate supervisor communication and a hassle-free commute as important characteristics. The lowest average importance scores are not as extreme as the highest scores since the lowest score is still above 2.0, which corresponds to a rating of slightly important. The respondents rate the ability to care for dependents the least important; however, this result is probably influenced by the number of respondents who have dependents.

Table 3-7: Most Important Work Characteristics

Rank	Characteristic	Score
1	Working effectively	3.85
2	Having the equipment and services needed to work effectively	3.74
(tie)	Having my work judged by its results	3.74
4	Having my supervisor be comfortable with my work	3.67
5	Commuting to work without a hassle	3.59

Table 3-8: Least Important Work Characteristics

Rank	Characteristic	Score
1	Having the ability to care for a dependent(s)	2.37
2	Being visible to management	2.41
3	Running errands while commuting to or from work	2.52
4	Working while sick or disabled	2.56
5	Working in a professional appearing environment	2.74

3.2.5 Amount of Telecommuting

At the time of the after survey wave, the center-based telecommuters had, on average, about one year's experience with telecommuting from the center. (This estimate includes both the RABO and non-RABO telecenter users, the latter of whom had been telecommuting much longer, on average). Less than half of the sample (43.6%) reported that they had also telecommuted from home for an average of 2.84 years. In the initial survey, 19 out of 27 (70.4%) had not telecommuted before participating in the study.

When asked about the ideal distribution of work time among various locations (see Table 3-9), the respondents, on average, allocated nearly equal amounts of their time to both the regular workplace (44.6%) and to the telecommuting center (41.5%). Home was a distant third at 8.6%, with other locations, such as site visits and sales meetings, making up the remaining 5.4%. Although the variation within the data is quite high, the averages themselves remained basically the same for both versions of the survey (for those who answered both). The respondent was also asked to distribute his/her work hours if the telecenter were unavailable. In this case, the members of the sample would spend two-thirds of their time at the main office (67.8%), 23.7% at home, and 8.5% at other locations, which evenly divides the time allocated to the center in the previous question between the regular workplace and home.

Table 3-9: Employees' Ideal Distribution of Work Time
(Mean and Standard Deviation)

Work Location	Reduced (N = 27)		Full (N = 37)
	Before	After	After
Regular workplace	39.2% (25.6)	41.3% (24.0)	44.6% (24.8)
Telecenter	49.0% (25.9)	46.8% (23.2)	41.5% (22.7)
Home	9.1% (14.9)	6.3% (11.8)	8.6% (14.7)
Other	2.8% (12.6)	5.6% (13.9)	5.4% (12.4)

The ideal distribution of time at the various workplaces can also show which combinations of work locations are preferred. Table 3-10 shows the frequency of selecting the possible workplace combinations from the after survey data. Not surprisingly, the most preferred alternative was to work at both the regular workplace and the telecenter (41.0%) and, on average, to split the work time evenly between the two locations. However, the next most preferred alternative was to work at home in addition to the previous two locations (23.1%). So, even though the sample is composed of telecenter users, a sizeable percentage are still interested in doing some telecommuting from home. If the other work location is included with the regular workplace (both of which can be considered essential to the job), then nearly all participants fall into two work arrangement categories: regular workplace/telecenter (53.8%) and regular workplace/telecenter/home (30.8%).

The survey included a question designed to find out what the telecommuter does with the time saved by telecommuting. The most frequently checked responses (more than one response could be marked) were spending time with family or friends (66.7%), getting more sleep (51.3%), and relaxing by myself (43.6%). Other important activities included housework or yardwork (38.5%) and exercise (35.9%). Equal numbers of respondents marked working, shopping, and participating in an outdoor activity (25.6%). Only 4 respondents (10%) said there was no significant time saved. When asked which one of the previously-checked activities they did most frequently during the time saved by telecommuting, a sizeable portion of the respondents cited spending time with family or friends (38.5%). Other "most frequent" activities included working (12.8%) and housework or yardwork (10.3%).

Table 3-10: Employees' Distribution of Workplace Combinations and Ideal Distribution of Work Time

Workplace Combination	Number (Proportion)	Mean Ideal Distribution of Time[1]			
		RW	TC	HM	OL
RW/TC	16 (41.0%)	50.2%	49.8%	---	---
RW/TC/HM	9 (23.1%)	55.6%	28.7%	15.8%	---
RW/TC/OL	5 (12.8%)	44.0%	29.0%	---	27.0%
ALL	2 (5.1%)	22.5%	27.5%	22.5%	27.5%
TC/HM	2 (5.1%)	---	70.0%	30.0%	---
RW/HM	1 (2.6%)	80.0%	---	20.0%	---
TC	1 (2.6%)	---	100.0%	---	---
TC/HM/OL	1 (2.6%)	---	40.0%	50.0%	10%
Total	37 (94.9%)	44.6%	41.5%	8.6%	5.4%
Missing	2 (5.1%)				

[1] Workplace locations are the regular workplace (RW), the telecommuting center (TC), home (HM), and other location (OL).

A set of five questions compares telecommuting from a center and from home. The first two questions ask about the possibility of telecommuting based on job suitability and manager support, respectively, and the last three ask for the current, preferred, and predicted amount of telecommuting (see Table 3-11). The mean telecommuting frequencies given in Table 3-11 were calculated by averaging the responses weighted by the average for each frequency category as shown in the lower section of the table.

For the full data set, telecenter users thought their jobs were suitable for telecommuting from a center about 40% of the time, on average. However, they only currently telecommuted from a center 30% of the time even though they wanted to use the center 50% of the time. Average frequencies of telecommuting from home were lower than from a telecenter for all five questions. Respondents felt that their jobs were suitable for telecommuting from home only about 27% of the time on average, suggesting that some parts of their jobs could be done remotely but required the context of a typical office environment. Accordingly, the telecenter users chose to telecommute from home much less frequently (9.6% of the time, on average) than from a center and preferred to telecommute from home much less frequently (20%). Over the next six months, the respondents predicted a slight increase in the frequency of both forms of telecommuting. (The levels of actual telecenter use based on the attendance logs are described in Section 4.4.2).

It is of interest to analyze how the responses to these five questions change with telecenter experience. For the reduced data set, the frequency of telecommuting was significantly different between the two waves for three of the questions according to a pairwise t-test of the means (see Table B-1, Appendix B). After gaining experience with telecommuting from the center, respondents thought that their supervisors were likely to allow them to telecommute from home more frequently than before ($p = 0.047$). Thus, familiarity with one form of telecommuting makes the adoption of other forms more likely. Not surprisingly, the frequency of telecommuting from the center increased significantly ($p = 0.021$). However, the change between the survey waves is not as great as might be expected due to a number of respondents who had already begun to telecommute from the center. Although the survey was to have been administered prior to the start of telecenter use, it was not always possible to reach a respondent or to have a survey ready before telecommuting actually began. In fact, fifty-two percent of the respondents (from the reduced data set) stated that they currently telecommuted from a center on the before survey, although most of those had probably been telecommuting less than a month. Additionally, the expected frequency of center-based telecommuting declined between surveys ($p = 0.013$). Whereas respondents initially expected on average to be telecommuting from a center 50% of the time within six months, their predicted future telecommuting frequency was only 38% after having telecommuted for some time, which is essentially equal to their current actual frequency of 39%. Thus, the later estimate appears to be a more realistic alignment of expectations with reality.

Table 3-11: Relative Telecommuting Frequency

a. Proportion of Work Week - Mean and Standard Deviation (N = 39)

After	Job	Supervisor	Choice	Prefer	Expect
From a center	40.5% (29.0)	40.8% (30.7)[1]	29.9% (28.1)	50.4% (27.2)	33.1% (26.4)
From home	26.6% (27.6)	27.0% (31.1)[1]	9.6% (21.4)[1]	20.0% (26.4)[1]	11.7% (23.3)[2]

b. Proportion of Work Week - Mean and Standard Deviation (N = 27)

Before	Job	Supervisor	Choice	Prefer	Expect
From a center	46.9% (22.5)[3]	41.5% (27.0)[3]	21.6% (28.2)[3]	59.2% (26.8)[3]	50.0% (28.3)[3]
From home	25.3% (28.2)[3]	16.8% (17.6)[3]	9.9% (21.9)[3]	16.4% (19.1)[4]	13.6% (24.3)[3]
After					
From a center[5]	46.9% (31.2)	44.9% (31.8)[3]	**38.9%** (29.0)	58.5% (24.1)	**38.0%** (28.0)
From home[5]	29.8% (30.2)	**30.6%** (32.0)[3]	9.8% (21.9)[3]	22.1% (28.7)[3]	9.9% (21.3)[3]

[1] N = 38 [2] N = 37 [3] N = 26 [4] N = 26

[5] Bolded after means are significantly different from their before counterparts at $\alpha \leq 0.05$. See Table B-1, Appendix B for the test statistics.

Survey Question Definitions

Job — Considering the requirements of your current job, how much do you think **the nature of your job** would allow you to telecommute . . . ?

Supervisor — Considering the characteristics of your current supervisor, how much do you think **your supervisor** would let you telecommute . . . ?

Choice — How much do you **currently** telecommute . . . ?

Prefer — Assuming that there are no work-related constraints, how much **would you like** to telecommute . . ?

Expect — Six months from now, how much **do you expect** to be telecommuting . . . ?

c. Values Used in Frequency Calculation

Frequency Category	Definition		Assigned Value
Not at all	0 days per month	0/22 = 0	0
Less than once a month	0.5 day per month	0.5/22 = 0.0227	0.0225
About 1 - 3 days a month	2 days per month	2/22 = 0.091	0.09
1 - 2 days a week	1.5 days per week	1.5/5 = 0.30	0.30
3 - 4 days a week	3.5 days per week	3.5/5 = 0.70	0.70
5 days a week	5 days per week	5/5 = 1.0	1.00
Occasional partial days	Equated with "Less than once per month"		0.0225

Comparing the distribution of the frequency categories for the five questions shows some important differences between telecommuting locations (see Table 3-12). Although all respondents felt that the nature of the job allows them to work from the telecommuting center for some amount of time, approximately 20% of the respondents considered themselves unable to telecommute from home for the same reason. Even more respondents (about 30%) felt that their supervisor was unwilling to let them work at home at all. Cross-tabulating these two results shows that the option of telecommuting from home is not available to almost 40% of the telecenter users which indicates that centers may help spread the transportation and other benefits of telecommuting to a larger segment of the workforce than home-based telecommuting alone would. Setting an arbitrary telecommuting frequency criterion at one day per month or more, the full after survey results show that 79.5% of the respondents meet this level of telecommuting at the center. Using the same marker, 20.6% currently telecommute from home. In fact, 12.5% spend one day per month or more working at both telecommuting locations.

Table 3-12: Employee Telecommuting Frequency (Number and Proportion)

From a Center[1]	Not at all	Less than once a month	About 1-3 days a month	1-2 days a week	3-4 days a week	5 days a week	Occa-sional partial days
Job	0	0	9 (23.1%)	18 (46.2%)	8 (20.5%)	4 (10.3%)	0
Manager[2]	0	0	8 (20.5%)	20 (51.3%)	4 (10.3%)	6 (15.4%)	0
Choice	1 (2.6%)	6 (15.4%)	10 (25.4%)	11 (28.2%)	9 (23.1%)	1 (2.6%)	1 (2.6%)
Prefer	0	1 (2.6%)	2 (5.1%)	15 (38.5%)	17 (43.6%)	3 (7.7%)	1 (2.6%)
Expect	4 (10.3%)	0	9 (23.1%)	16 (41.0%)	9 (23.1%)	1 (2.6%)	0
From Home[1]							
Job	7 (17.9%)	3 (7.7%)	5 (12.8%)	18 (46.2%)	2 (5.1%)	3 (7.7%)	1 (2.6%)
Manager[2]	11 (28.2%)	1 (2.6%)	3 (7.7%)	15 (38.5%)	2 (5.1%)	4 (10.3%)	2 (5.1%)
Choice[2]	25 (64.1%)	4 (10.3%)	0	6 (15.4%)	1 (2.6%)	1 (2.6%)	1 (2.6%)
Prefer[2]	12 (30.8%)	3 (7.7%)	5 (12.8%)	12 (30.8%)	2 (5.1%)	2 (5.1%)	2 (5.1%)
Expect[3]	20 (51.3%)	4 (10.3%)	3 (7.7%)	5 (12.8%)	2 (5.1%)	1 (2.6%)	2 (5.1%)

[1] See Table 3-11 for the text of the survey questions.
[2] N = 38 [3] N = 37

It appears that the respondents would like to work from the telecommuting center more often than they are currently doing so since the three highest frequency categories are much larger than for the question on current amount of telecommuting. Also, a good portion of the telecenter users do not want to work at home (30%). Finally, although most respondents expected to be telecommuting more often six months after completing the survey, four of the respondents (10.3%) planned to stop using the telecenter. Again, some telecenter users did not expect to be

telecommuting from home (51.3%). Overall, the results from the choice, preference, and expectation questions indicate that combined home and center telecommuting appears to be a popular option.

3.2.6 Travel Characteristics

On average, the commute to the regular workplace took 62.2 minutes to travel 44.2 miles. The average commute to the telecommuting center took about 10 minutes to travel 7.3 miles. Thus, on days that the participants used the center *instead of* going to the regular workplace, their commute travel was reduced, on average, by 36.9 miles. (This estimate includes two participants who traveled 5 and 12.5 miles, respectively, farther to the center than to the regular workplace. For the first case, no first-hand explanation is available, but it is supposed that the employee used the center to work with her supervisor, a telecenter user, and/or work at a nearby field site. In the other case, the employee was actually using the center temporarily before obtaining permanent space for a branch office near the center.)

On the initial survey, respondents were asked to divide their total commute between miles on freeways and miles on other roads. For the commute to the regular workplace, 35.9 miles were traveled on freeways compared to 5.9 miles on other roads, on average. The trip to the telecenter was composed of 4.6 freeway miles and 2.4 non-freeway miles. Interestingly, a larger portion of the travel to the telecenter was done on freeways than on surface streets.

Examining the difference between the RABO sites, which were established near residential areas for the most part, and the non-RABO sites, at least one of which is located in a light-industrial park, provides some insights into the effects of telecenter location (see Table 3-13). Although RABO participants had shorter commutes to the telecenter (6.5 vs. 9.1 miles), non-RABO respondents had a greater reduction in travel since their regular workplace was farther away, on average (53.1 vs. 39.1 miles). Non-RABO participants traveled more on freeways (6.8 vs. 4.1 miles) when commuting to the telecenter than RABO participants and approximately the same amount on other roads (2.3 vs. 2.4 miles).

Table 3-13: Average Distance to Work Locations

Location	Roadway Type	One-way Distance (miles)		
		RABO (N=21)	Non-RABO (N=5)	Total (N=26)
Regular workplace	Freeway	32.5	50.5	35.9
	Surface streets	6.6	2.6	5.9
	Total	39.1	53.1	41.8
Telecenter	Freeway	4.1	6.8	4.6
	Surface streets	2.4	2.3	2.4
	Total	6.5	9.1	7.0

The section of the survey covering travel characteristics also includes a series of questions about residential relocation. Of the 39 respondents, only 2 (5.1%) had moved in the past year: one moved closer to work and the other moved farther away. Contrary to expectation, the former respondent stated that telecenter use was a somewhat important factor in the relocation decision, while the latter respondent stated that telecenter use was not a factor. A larger number of respondents were considering residential relocation. Of these 7 (17.9%), 5 planned to move closer to work and the other two would move either closer to or farther from work. However, a majority of those planning to move did not believe that telecommuting (5 of 7) or telecenter location (4 of 7) were important factors in the relocation decision. So, although telecommuting is anticipated to allow residents to locate farther from work since the total weekly commute distance decreases, there is little measurable impact for this small sample at this early point in the telecommuting experience. For a more complete analysis of the travel impacts of the telecenters, including a comparison of modes of travel to the regular workplace and to the telecommuting center, see Chapter 6.

3.2.7 Summary of Employee Survey Results

In this interim report, the description of the survey data is restricted to the telecenter users only. Primarily, the data from the after-wave surveys is used to characterize center-based telecommuters (sample size of 39). However, where appropriate, data from both before and after waves are utilized to highlight changes related to the use of telecenters (a reduced sample size of 27). A summary of the results from the six parts of the survey is provided below.

The section on demographics asked for general characteristics, such as age, income, and education. There are slightly more female telecenter users than male ones, and nearly half the sample is between the ages of 35 to 44 years. The average household size of three persons is consistent with the fact that more than half of the respondents have children under 16 years of age. Vehicle availability is high among the respondents with 2.3 vehicles per household and 1.4 vehicles per worker. The telecenter users are highly educated: about 30% have had additional schooling after college. Additionally, many of the participants have high incomes (about 70% have annual household incomes greater than $55,000).

Job characteristics varied among the center-based telecommuters. Slightly over half of the sample hold professional/technical positions which are usually easily adapted to telecommuting, and as a whole, they are experienced in their field with an average length of time in the profession of 10.2 years. Flextime schedules are popular among the telecenter users (used by nearly 65%). Finally, the respondents spend a good portion of their workday working independently (47%) or remotely (18%), both of which are good indicators of positions with telecommutable tasks.

The responses from the attitudinal sections on job performance and satisfaction and work environment characteristics show primarily positive results. There is little change in performance or satisfaction characteristics between survey waves suggesting that working from a telecommuting center does not drastically change these factors. The only significant change was a slight drop in the perceived opinion of the supervisor on the telecommuter's ability to meet deadlines. The ratings on the statements about work characteristics also remained primarily the same between survey measurements. Distractions at the telecenter were slightly more of a problem than originally envisioned, but the average response on the after survey is still to disagree with the statement that distractions were a problem. Finally, the most important work

characteristics to the respondents are working effectively, having needed equipment, and having work judged by the results.

The survey also measured the amount of telecommuting the telecenter users had done, are currently doing, and plan to do in the future. The average experience with telecommuting from a center was about one year at the time of the after survey, and about half also had experience with home-based telecommuting. On the other hand, about 40% of the respondents did not have the option to telecommute from home which indicates that centers may help spread the transportation and other benefits of telecommuting to a larger segment of the workforce. With the time saved by telecommuting, the respondents most often spend time with family or friends, get more sleep, and/or relax by themselves.

When distributing their work time for the ideal situation, the respondents preferred to work from the regular workplace and the telecenter about equal amounts, 40% to 45% of their time (each) on average. However, they actually reported telecommuting only about 30% of the time even though their jobs were suitable for telecommuting for about 40% of the time, on average (see Section 4.4.2 for actual telecommuting frequency based on attendance log data). The respondents predicted greater frequencies of future center-based telecommuting than current levels (38%), but that expected frequency was substantially lower than was reported on the before survey (50%). In addition, the results from the choice, preference, and expectation of telecommuting indicate that combined home and center telecommuting appears to be a popular option.

In the section on travel, the commute to the regular workplace was reported as 44.2 miles in length, while the commute length to the telecommuting center was given as 7.3 miles, on average. The resulting average commute travel savings by using the center *instead of* going to the main office for the after survey respondents is 36.9 miles. Despite the reduction in travel, the majority of travel to the telecenter is on freeways, suggesting that the centers are far from the average participant's residence. This is especially true of the respondents from non-RABO centers who have longer commutes than RABO telecommuters, on average, to both the regular workplace (53.1 vs. 39.1 miles) and the telecommuting center (9.1 vs. 6.5 miles). Additionally, telecenter use was not found to have much effect on residential relocation decisions in this short time frame.

The tabulations of the attitudinal surveys provide a good characterization of the telecommuting center users. However, the survey data will also be used to model the decision to adopt telecommuting. Further analysis will be presented in the final report and/or in subsequent studies.

3.3 Manager Survey Results

Attitudinal surveys for managers targeted the supervisors of the employees who participated in the project. The number of returned manager surveys for the two waves and three study groups is shown in Table 3-1. There were a total of 49 respondents for the before survey (33 managers of center-based telecommuters; 16 managers of home-based and non-telecommuters), and 34 for the after survey (28 center-based; 6 home-based and non-telecommuters). Attrition in the second wave is due both to employees dropping out of the study (in which case an "after" survey from the manager is unnecessary) and to failure on the part of the manager to return the questionnaire.

Similarly to the previous section, this section focuses on analyzing the after survey for telecenter participants, that is the perceptions of the supervisors after their employees had used the telecenter

for several months. The findings are based mainly on the information of the 28 managers of telecenter users who returned the after survey. These 28 surveys represent a 60.9% response rate for 46 managers of the telecenter users.

Of the 28 respondents, 13 were from RABO sites and 15 were from non-RABO sites. In addition, only 14 supervisors responded to both before and after surveys. When comparisons of responses between the two survey waves are of interest, the analysis is based on the information collected from these 14 respondents. Of the remaining 14 supervisors who returned the after survey but not the before survey, two respondents were new managers for continuing telecommuters and the other 12 respondents were managers of new participants in the study. These new participants, who were from the non-RABO site at Ontario, had already been telecommuting for some time before joining the study, and hence neither they nor their managers could complete the before survey.

Although the surveys of the participating employees and their managers were conducted in parallel, there is not necessarily a manager survey for each employee and vice versa. Among the telecenter participants, 39 employee surveys and 28 manager surveys were returned for the after wave. However, there are only 19 employee-manager pairs in the sample. Therefore, the average responses of the 28 managers may not completely reflect the behavior of the 39 employees whose responses are presented in Section 3.2. Comparisons of the responses between managers and employees are discussed in detail in Section 3.4.

The questionnaire design was similar for both survey waves, with the after survey obtaining additional information about telecommuting. The survey contains six parts:

Part A: Job characteristics of the employee.
Part B: Assessments of the employee's job performance and satisfaction.
Part C: Attitudes toward the employee working at three different work environments: regular workplace, telecenter and home.
Part D: Perceptions of the advantages of telecommuting.
Part E: Perception of telecommuting as a work option, including general attitudes toward telecommuting within various management levels of the organization, information on the amount of time for the employee to telecommute, and intentions regarding continuing the telecommuting program.
Part F: Demographic data, including gender, age, job tenure, education level, and frequency of computer usage.

The sections that follow describe the responses to each part of the survey in the order in which each part appears, except that the demographic information is presented first in order to describe the nature of the sample. The after survey of managers of telecenter users is attached to this report as Appendix F.

3.3.1 Demographic Characteristics

The demographics given below describe the 28 managers who returned the after survey. The gender of these respondents was equally distributed, with 14 females and 14 males. Half of the supervisors were between the ages of 45 and 54 years old. The next largest age groups, which each accounted for 17.9% of the sample, were 25 to 34 and 35 to 44 years of age. The remainder (14.3%) were in the category of 55 to 64 years old. On average, respondents had

worked for their current organizations for 11.9 years and had worked as supervisors for more than 8 years.

The majority (71.4%) used a computer for several hours per day on the job. Only 2 persons did not use a computer at all while working. Approximately 79% of the respondents held at least a four-year college degree: 25.1% had obtained a bachelor's degree and another 53.5% had completed one or more graduate degrees. Half of the 28 supervisors (50%) came from organizations with more than 500 employees. Eight persons (28.6%) worked for an organization with 10 to 49 employees. Of the remainder, 1, 2, and 3 respondents came from organizations with 1 to 9, 50 to 99, and 100 to 499 employees, respectively. Thus, in this small sample, large organizations are the dominant participants in center-based telecommuting. This is in contrast to other, larger-sample studies of home-based telecommuting, where adoption has been found to be more prevalent among small-to-medium size employers.

3.3.2 Job Characteristics of Employees

In the first part of the survey, respondents were asked to give some background information on their employees' jobs. Supervisors of the 28 telecenter users reported that their participating employees worked for 83.9 hours in two weeks on average. Table 3-14 shows the items or services which the supervisors thought that the employees would need to work as effectively at the telecenter as they did at the regular workplace. The most frequently-selected items were personal computer and copier. Other frequent responses include fax machine, printer, software and modem. More than half of the supervisors thought that voice mail, conference calling, and electronic mail were essential to employees working effectively at the telecenter. Thus, the ability of center-based telecommuters to keep in touch with their supervisors, clients, and co-workers is important to most of the managers.

Table 3-14: Items or Services Thought to Help Employees Work Effectively at the Telecenter (N=28)

Item/Service	Number (Proportion)	Item/Service	Number (Proportion)
Personal computer	27 (96.4%)	Overnight package pickup / delivery	10 (35.7%)
Copier	27 (96.4%)	Files or reference materials	7 (25.0%)
Fax machine	26 (92.9%)	Secretarial services	6 (21.4%)
Printer	26 (92.9%)	Restaurant / Cafeteria	6 (21.4%)
Software	23 (82.1%)	Call forwarding	4 (14.3%)
Modem	22 (78.6%)	Video-conferencing	4 (14.3%)
Voice mail	21 (75.0%)	Private office	4 (14.3%)
Conference calling	18 (64.3%)	Call waiting	3 (10.7%)
Electronic mail	17 (60.7%)	Document production services	3 (10.7%)
Lockable storage area	14 (50.0%)	Other (Internet connection)	1 (3.6%)

3.3.3 Assessment of Employee Performance

In Part B of the survey, supervisors were asked to evaluate their employees' performance in various ways. The average responses are shown in Table 3-15. The first question asked the supervisors to evaluate their employees (on a five-point scale from "terrible" to "excellent") regarding the amount of work completed, quality of work, ability to meet deadlines, and overall productivity. Most of the employees were rated as "good" (4) or "excellent" (5).

Table 3-15: Supervisors' Ratings of Their Employees in the After Survey (N=28)

Statements	Average Rating (Std. Dev.)
Amount of work completed	4.32 (0.77)
Quality of work	4.36 (0.73)
Ability to meet deadlines	4.32 (0.72)
Overall productivity	4.29 (0.76)
Employee communicates effectively[1]	4.32 (0.48)
Adequate resources are available[1]	4.11 (0.63)
Employee's work team is effective	4.04 (0.66)
Employee works well with supervisor	4.21 (0.69)
Clients demand a reasonable amount of time[1, 2]	3.12 (0.85)
Supervisor is satisfied with employee's performance	4.39 (0.69)
Supervisor expresses enough appreciation[1]	3.14 (1.04)
Employee gets along well with co-workers[1]	4.32 (0.67)
Employee has ability to do the job	4.54 (0.51)
Employee is likely to stay at current job[1]	3.71 (0.76)
Employee works well with subordinates[3]	3.85 (0.69)

[1] Statements were negatively worded on the survey, but changed to a positive orientation for comparison with other responses.
[2] N = 24 [3] N = 13

To see if telecommuting had an impact on supervisors' assessments, responses in the before and after waves are compared for the 14 managers completing both surveys. The results of conducting paired-t tests on each statement are given in Table 3-16. None of the statements shows a significant change under even a 0.10 level of significance. Thus, for this small sample, it appears that telecommuting did not alter the managers' perception of their employees' work abilities either for better or for worse.

The second question asks the respondents to express an opinion (a five-point scale from "strongly disagree" to "strongly agree") regarding the work effectiveness of their employees along several dimensions. On the whole, the supervisors were satisfied with their employees' performance. Employees were believed to perform well on a team and to work well with the supervisor as well as with their own subordinates (where applicable). Also, they were still considered to communicate well with supervisors and their co-workers after the start of telecommuting.

Table 3-16: Change in Supervisors' Ratings of Their Employees (N=14)

Statements	Before Mean (S. D.)	After Mean (S. D.)	2-tail p-value
Amount of work completed	4.36 (0.75)	4.57 (0.51)	0.189
Quality of work	4.43 (0.65)	4.50 (0.52)	0.189
Ability to meet deadlines	4.29 (0.73)	4.50 (0.52)	0.435
Overall productivity	4.29 (0.83)	4.43 (0.65)	0.327
Employee communicates effectively[1]	4.07 (0.83)	4.29 (0.47)	0.336
Adequate resources are available[1]	4.07 (0.48)	3.93 (0.73)	0.435
Employee's work team is effective	3.85 (0.90)	4.23 (0.60)	0.175
Employee works well with supervisor	4.07 (0.83)	4.21 (0.70)	0.612
Clients demand a reasonable amount of time[1, 2]	3.10 (1.10)	3.20 (0.92)	0.343
Supervisor is satisfied with employee's performance	4.43 (0.85)	4.50 (0.52)	0.720
Supervisor expresses enough appreciation[1]	3.57 (0.94)	3.21 (1.05)	0.315
Employee gets along well with co- workers[1]	4.14 (0.66)	4.21 (0.70)	0.720
Employee has ability to do the job	4.38 (0.93)	4.50 (0.52)	0.500
Employee is likely to stay at current job[1]	3.36 (1.08)	3.71 (0.83)	0.208
Employee works well with subordinates[3]	4.67 (0.58)	4.00 (1.00)	0.184

[1] Statements were negatively worded on the survey, but changed to a positive orientation for comparison with other responses.

[2] N = 10 [3] N = 3

3.3.4 Attitudes Toward Different Work Environments

In Part C of the survey, supervisors' attitudes toward their employees working at three different work environments (regular workplace, telecenter, and home) were investigated using a series of

attitudinal statements with a five-point response scale (from "strongly disagree" to "strongly agree"). The average ratings on each statement for each of the three workplaces are shown in Figure C-1, Appendix C. A three-level one-way analysis of variance (ANOVA) test was conducted for each statement to determine if supervisors' attitudes differ significantly across the three workplaces. Table 3-17 shows the results of the F-test for equality of means for each ANOVA, as represented by the p-values. Under a 0.10 level of significance, the effect of the workplace factor was significant for 16 of the 22 statements. The effect was insignificant for the employee indulging (C5), relative independence (C6), having the option to work when sick or disabled (C12), having the freedom to adjust the work schedule (C13), having work judged by the results (C15), and having high worker's compensation liability (C21).

In general, the supervisors favor working at home the least. The mean rating for the telecenter generally falls between the average rating for the regular workplace and home. Despite this, the respondents rated the telecenter similarly to or better than the regular workplace on the following aspects: employee being easily motivated (C1), supervisor's level of comfort (C2), workplace having a professional appearance (C3), having fewer distractions from others (C4), being good for the environment (C7), supervisor feeling confident (C10), costing too much (C11), and employee working effectively (C18).

Meanwhile, center-based telecommuting had some relative disadvantages compared to the regular workplace, with the telecenter being rated less positively on statements such as the employee not being visible to management (C8), the employee not having needed equipment (C9), the employee being unavailable (C14), not having enough professional interaction (C16), poor communication with the employee (C17), telecommuting being an administrative burden (C19), security of confidential information (C20), and lower perceived security for the organization's property (C22). However, it is important to realize that the mean ratings on all of these statements were neutral or favorable, just less favorable than the ratings for the regular workplace. Hence, these attitudes toward the telecenter are not negative in the absolute sense. Further, these attitudes seem to apply to telecommuting in general since home-based telecommuting had even more unfavorable average responses than the telecenter in each of the above statements except the last two (C20 and C22).

To examine how the supervisor's perceptions of the various workplaces may have changed with the introduction of center-based telecommuting, two-way ANOVA tests were performed on the same attitudinal statements for the 14 respondents common to both survey waves. The results are shown in Table 3-18. The effect of the workplace factor is significant for most of the same statements as in the previous ANOVA. As to the effect of the wave factor, the data indicates that the mean ratings are statistically different (at a 0.10 level of significance) for the following four statements: costing too much (C11), having the option available to work when sick or disabled (C12), employee having the freedom to adjust the work schedule (C13), and employee not having enough professional interaction (C16). In other words, the supervisors' attitudes on these statements changed significantly after their employees began telecommuting from the center.

Table 3-17: One-way ANOVA Results for Supervisors' Attitudes Toward Different Work Environments in the After Survey (N=28)

Statements	Workplace Factor[1]
C1. Employee is easily motivated	**0.010**
C2. Supervisor feels uncomfortable	**0.017**
C3. Workplace has professional appearance	**0.000**
C4. Employee is distracted by others	**0.000**
C5. Employee indulges	0.768
C6. Employee is relatively independent	0.102
C7. Beneficial to the environment	**0.023**
C8. Employee is not visible to management	**0.000**
C9. Employee does not have needed equipment	**0.000**
C10. Supervisor feels confident in employee	**0.013**
C11. Costs too much	**0.002**
C12. Offer option when sick or disabled	0.326
C13. Employee can adjust work schedule	0.133
C14. Employee is unavailable	**0.001**
C15. Employee's work is judged by results	0.364
C16. Employee does not have enough professional interaction	**0.000**
C17. Poor communication with employee	**0.000**
C18. Employee works effectively	**0.018**
C19. Administrative burden	**0.002**
C20. Security of confidential information	**0.087**
C21. High worker's compensation liability	0.522
C22. Organization's property relatively secure	**0.035**

[1] The numbers given are the p-values of the F-test for equality of means across workplaces. Values in boldface type are significant at $\alpha \leq 0.10$.

Table 3-18: Two-way ANOVA Results for Supervisors' Attitudes Toward Different Work Environments in Both Survey Waves (N=14)

Statements[1]	Workplace Factor[2]	Wave Factor[3]	Inter-action[4]
C1. Employee is easily motivated	**0.002**	0.881	0.437
C2. Supervisor feels uncomfortable	**0.004**	0.561	0.838
C3. Workplace has professional appearance	**0.000**	0.496	0.815
C4. Employee is distracted by others	**0.002**	0.524	0.237
C5. Employee indulges	0.542	0.797	0.806
C6. Employee is relatively independent	0.614	0.134	0.505
C7. Beneficial to the environment	**0.000**	0.641	0.605
C8. Employee is not visible to management	**0.000**	0.561	0.804
C9. Employee does not have needed equipment	**0.000**	0.173	0.854
C10. Supervisor feels confident in employee	**0.026**	0.516	0.983
C11. Costs too much	**0.001**	**0.092**	0.337
C12. Offer option when sick or disabled	**0.016**	**0.000**	0.415
C13. Employee can adjust work schedule	0.272	**0.003**	0.537
C14. Employee is unavailable	**0.001**	0.350	0.516
C15. Employee's work is judged by results	0.283	0.171	0.971
C16. Employee does not have enough prof. interaction	**0.000**	**0.083**	0.855
C17. Poor communication with employee	**0.018**	0.782	0.874
C18. Employee works effectively	**0.006**	0.357	0.752
C19. Administrative burden	**0.002**	1.000	0.589
C20. Security of confidential information	0.393	0.140	0.955

[1] Statements C21 and C22 appeared only in the after survey, and hence cannot be tested across waves.

[2] The numbers given are the p-values of the F-test for equality of means across workplaces. Values in boldface type are significant at $\alpha \leq 0.10$.

[3] The numbers given are the p-values of the F-test for equality of means across survey waves. Values in boldface type are significant at $\alpha \leq 0.10$.

[4] The numbers given are the p-values of the F-test for the interaction between the workplace and wave factors.

The average ratings for the four statements with a significant wave effect are shown in Figure C-2 of Appendix C. We see that first, the perception that center-based telecommuting costs too much has changed. On average, respondents disagreed more strongly on the after survey with the statement that telecommuting from a center would cost the organization too much. However, managers similarly changed their opinion about the costs of working from the regular workplace, suggesting that the change may not be simply caused by telecenter use. Second, it was found in the after wave that the supervisors were more likely to offer employees the option to work from any of the three workplaces when sick or disabled. It may be that telecommuting has raised supervisors' awareness of the potential for accommodating such needs from a variety of locations. Third, in the after survey these supervisors reported that at all three workplaces their employees had even more freedom to adjust their work schedules than they had indicated prospectively in the before survey, with the two telecommuting options having the highest scores. Perhaps the trust gained in telecommuting has spread to other parts of the job. Finally, although telecommuting is still perceived to offer less professional interaction than the regular workplace, the managers were less concerned about interaction after several months' experience with telecommuting. For the other 16 statements, there were no significant differences between survey waves.

3.3.5 Potential Advantages of Telecommuting

In Part D of the survey, the perceptions of the supervisors themselves and their perceptions of their organizations' official views on the advantages of implementing telecommuting were obtained through a series of attitudinal statements using a four-point scale ("no opinion", "not significant", "moderately significant", and "extremely significant"). The survey instructions specifically requested the respondent to distinguish between "no opinion" and "not significant", where the latter in fact represents a considered opinion. While acknowledging that the distinction may sometimes be difficult to make in practice, the belief is that a high proportion of "no opinion" ratings on a given characteristic may indicate an undervalued advantage of telecommuting. This suggests that marketing strategies emphasizing those characteristics may help to raise the perceived value of telecommuting to management.

Table 3-19 lists the proportion of supervisors and organizations having no opinion on each of the 11 advantages named in Part D. From one-sixth to one-third of the organizations did not have opinions on certain potential advantages of telecommuting. In contrast, most of the supervisors had their own opinions on these statements. Assuming that supervisors' direct contact with the telecommuters affords them greater experience with the benefits of telecommuting than upper management would have, and assuming that supervisors were offering their own opinions with the good of the organization as a whole in mind, it would appear that a full awareness of the business advantages of telecommuting have not filtered up to the top levels in the organization. Obviously, such awareness on the part of organization decision-makers will be important if telecommuting is to expand.

However, even supervisors had a relatively high "no opinion" rate on four advantages of telecommuting: an improved ability to recruit employees (11%), reduced health costs (14%), compliance with environmental regulations (14%), and an improved disaster response capability (21%). This suggests the need to raise awareness of the potential benefits of telecommuting in these areas.

Table 3-19: Percentage of Supervisors and Organizations With "No Opinion" on Advantages of Telecommuting (N=28)

Advantages	Manager	Organization[1]
D1. Improve employee retention	0	16.7%
D2. Save office space costs	0	16.7%
D3. Offer better customer service	3.6%	20.8%
D4. Improve ability to recruit employees	10.7%	29.2%
D5. Increase productivity	3.6%	25.0%
D6. Save parking costs	3.6%	25.0%
D7. Improve disaster response capability	21.4%	33.3%
D8. Reduce absenteeism	0	20.8%
D9. Reduce health costs	14.3%	25.0%
D10. Comply with environmental regulations	14.3%	16.0% [2]
D11. Improve employee relations	0	12.5%

[1] N = 24 [2] N = 25

The remaining three points on the scale ("not significant" to "extremely significant") have an ordinal relationship to each other and were assigned values of 1, 2, and 3, respectively. The mean ratings on each advantage for those who had an opinion are shown in Table 3-20. According to the supervisors' average rating, six potential advantages are viewed as being at least moderately significant following the introduction of center-based telecommuting: improved employee retention (D1), improved ability to recruit employees (D4), increased productivity (D5), compliance with environmental regulations (D10), improved employee relations (D11) and (marginally) reduced absenteeism (D8). Five potential advantages are viewed as being insignificant: savings on office space costs (D2), improved customer service (D3), savings on parking costs (D6), improved disaster response capability (D7), and reduced health costs (D9). The mean ratings for the organizations were lower than the managers' ratings on every statement except compliance with environmental regulations. However, none of these differences were statistically significant, except for increased productivity (D5). Supervisors view increases in employee productivity as a more important advantage of telecommuting than they think their organizations do.

3.3.6 Telecommuting as a Work Option

In Part E of the survey, respondents were asked about their experience with telecommuting, the extent to which telecommuting may be adopted by the organization, and how desirable it may be for the employee. To assess the general level of support for telecommuting within the organization, the survey asked about the existence of formal policies and general attitudes toward

telecommuting on the part of responding managers themselves, their immediate supervisors, and the organization as a whole. Among the 28 responses, 71.4% of the telecommuter managers themselves, 60.7% of their supervisors, and 60.7% of the organizations had formal policies supporting telecommuting. Twenty-five percent of the respondents, 32% of their supervisors, and 21.4% of the organizations did not have formal policies on telecommuting. One respondent thought that the organization had a formal policy *against* telecommuting. Four respondents (14.3%) did not know if there was a formal policy on telecommuting in the organization, and two did not know if their immediate supervisor had a formal policy.

Table 3-20: Average Ratings and ANOVA Results for Potential Advantages of Telecommuting in the After Survey (N=28)

Statements	Supervisor	Organization	Opinion Factor[11]
D1. Improve employee retention	2.14	1.85[1]	0.136
D2. Save office space costs	1.36	1.20[1]	0.329
D3. Offer better customer service	1.44[2]	1.37[3]	0.702
D4. Improve ability to recruit employees	1.88[4]	1.65[5]	0.193
D5. Increase productivity	2.11[2]	1.72[6]	**0.032**
D6. Save parking costs	1.19[2]	1.17[6]	0.877
D7. Improve disaster response capability	1.36[7]	1.31[8]	0.808
D8. Reduce absenteeism	1.64	1.42[3]	0.204
D9. Reduce health costs	1.29[9]	1.11[6]	0.166
D10. Comply with environmental regulations	1.96[9]	2.10[10]	0.532
D11. Improve employee relations	2.29	2.05[10]	0.119

[1] N=20 [2] N=27 [3] N=19 [4] N=25 [5] N=17 [6] N=18
[7] N=22 [8] N=16 [9] N=24 [10] N=21
[11] The numbers given are the p-values for the t-test for equality of means across the two management levels. Values in boldface type are significant at $\alpha \leq 0.10$.

When asked about the general attitude toward telecommuting, 93% of the respondents had a positive response. However, that percentage dropped to 61% for their supervisors and to 50% at the organizational level. Although none of the respondents themselves had negative attitudes toward telecommuting, they reported that nearly 11% of their supervisors and 18% of their organizations did. Seven percent of the respondents, 21% of the respondents' supervisors, and 32% of the organizations held neutral opinions on telecommuting. Thus, the higher the management level, the less positive was the attitude toward telecommuting. Indeed, it appears that some managers are supporting telecommuting for their staff in the face of actively negative attitudes on the part of upper management.

To ascertain the respondents' experience in managing telecommuters, they were asked how long they had supervised telecommuting employees. On average, respondents had supervised center-based telecommuters for 15.6 months and home-based telecommuters for 14.2 months. When asked about the proportion of the organization's workforce allowed to telecommute from the telecenter and from home within the next two years, around half of the respondents thought that it would increase for each form of telecommuting. However, approximately 40% of respondents expected no change in the proportion of telecommuters at their organization.

Overall, 82% of the supervisors had a high or very high level of satisfaction with center-based telecommuting. The other eighteen percent were neutral; none had low satisfaction with center-based telecommuting. With the center in its current state, half of the respondents believed that the organization would be likely to offer center-based telecommuting to other employees. Although only two respondents thought that other employees were unlikely to be offered the opportunity to telecommute from a center, 39% of the sample were unsure whether it would be made available to others.

When asked what, if anything, would need to change to make the organization likely to offer center-based telecommuting, the most frequently selected response (39.3%) was that "nothing more is needed, we are already likely to offer it". Other common responses included lowering the cost (29%), obtaining manager acceptance (27%), and having the ability to quantify the benefits to the organization (21%). Collectively, these three responses were cited as most important by 39% of the respondents. At least two of these three responses relate to justifying the cost of the center. Even though rental costs for using the center were partially or completely waived for many participants at this point in the demonstration, managers were likely responding both to existing costs of other kinds (monetary and non-monetary) and to expected future rental costs in a post-demonstration environment. Thus, it appears as though cost-justification is a critical issue in increasing the acceptance of center-based telecommuting. Manager acceptance may still be an issue apart from cost-benefit considerations (that is, even if telecenters were demonstrably cost-effective, managers may have other considerations); however, acceptance is likely to increase as proof of the benefits of telecommuting (relative to costs) becomes stronger.

Supervisors were asked about the ideal distribution of their employees' work time among alternative work locations. On average, they wanted their employees to spend 64% of the time at the regular workplace, 29% at the telecenter, 5% at home, and 4% at other locations such as client offices. Table 3-21 shows the distribution of responses among various workplace combinations and, for each combination, the average ideal distribution of work time at each location. The most favorable workplace combination is regular workplace and telecenter, which accounts for 57% of the responses. On average, under this workplace combination, the managers prefer their employees to spend 73.8% of work time at the regular workplace and 26.3% at the center. The second most common response (25%) is regular workplace, telecenter and home, where the average work time is distributed 60.7%, 30.0% and 9.3%, respectively. Collectively, the results of Table 3-21 suggest that (1) the manager still feels that the regular workplace is the primary work location, to be used three or more days out of the work week, (2) the manager is willing for the employee to telecommute nearly three times as much from the center as from home on average, and (3) for nearly one-third of the managers, some mixture of center and home-based telecommuting is considered ideal.

Table 3-21: Supervisors' Distribution of Workplace Combinations and Ideal Distribution of Work Time (N=28)

Workplace Combination	Number (Proportion)	Mean Ideal Distribution of Time[1]			
		RW	TC	HM	OL
RW/TC	16 (57.1%)	73.8%	26.2%	---	---
RW/TC/HM	7 (25.0%)	60.7%	30.0%	9.3%	---
RW	1 (3.6%)	100.0%	---	---	---
RW/TC/OL	1 (3.6%)	40.0%	30.0%	---	30.0%
ALL	1 (3.6%)	10.0%	10.0%	10.0%	70.0%
TC	1 (3.6%)	---	100.0%	---	---
TC/HM	1 (3.6%)	---	50.0%	50.0%	---
Total	28 (100.0%)	63.7%	29.2%	4.5%	3.6%

[1] Workplace locations are the regular workplace (RW), the telecommuting center (TC), home (HM), and other location (OL).

A series of questions asks the supervisor about several aspects of the employee's telecommuting frequency from a center and from home. In contrast to the above question in which respondents filled in blanks for the "percent of time" an employee would ideally spend at each location, responses to this series of questions consisted of categories ranging from "not at all" to "5 days a week". The first question relates to the nature of the employee's job and its suitability for telecommuting. The other questions ask for the current amount, the allowable amount, and the predicted amount of telecommuting of the employee. Table 3-22 shows the distribution of responses to the four questions. More than half of the respondents reported that their employees telecommuted from the telecenter one to two days per week. The distributions of the responses are similar for the four questions, suggesting that the responses are consistent across all four indicators of possible and actual telecommuting frequency. Looking six months into the future, the supervisors also expect that the amount of center-based telecommuting will remain approximately equivalent to current levels except that one manager thought the employee would not be telecommuting from the center at all. It is noteworthy that few managers expected their employees to be telecommuting from the center nearly full time. This is consistent with the result for the question regarding the ideal distribution of time across work locations.

Table 3-23 shows the mean telecommuting frequencies for the four categories based on the managers' responses. The calculation follows the similar method described in Section 3.2. The nature of the job allows employees to telecommute from a center about 1.5 days per week (32%), on average. Although the permitted frequency is 37%, the current rate and the expected future rate for center-based telecommuting is about 30% of the work time. It appears that the supervisors feel that employees are restricted in the amount of time that they can telecommute due to the nature of the job rather than due to the restrictions imposed by management.

Table 3-22: Supervisors' Perception of Employee Telecommuting Frequency (N=28)

From a Center	Not at all	Less than once a month	About 1-3 days a month	1-2 days a week	3-4 days a week	5 days a week	Occa-sional partial days
Job	0	0	6 (21.4%)	18 (64.3%)	3 (10.7%)	1 (3.6%)	0
Choice[1]	0	0	8 (28.6%)	15 (53.6%)	2 (7.1%)	1 (3.6%)	1 (3.6%)
Permit	0	0	4 (14.3%)	18 (64.3%)	5 (17.9%)	1 (3.6%)	0
Expect	1 (3.6%)	0	8 (28.6%)	15 (53.6%)	3 (10.7%)	1 (3.6%)	0
From Home							
Job	5 (17.9%)	4 (14.3%)	5 (17.9%)	8 (28.6%)	3 (10.7%)	0	3 (10.7%)
Choice	17 (60.7%)	2 (7.1%)	3 (10.7%)	4 (14.3%)	0	0	2 (7.1%)
Permit	6 (21.4%)	2 (7.1%)	6 (21.4%)	10 (35.7%)	2 (7.1%)	0	2 (7.1%)
Expect	13 (46.3%)	2 (7.1%)	6 (21.4%)	5 (17.9%)	0	0	2 (7.1%)

[1] N = 27

Survey Question Definitions

Job Considering the requirements of your employee's current job, how much do you think **the nature of your job** would allow him/her to telecommute . . . ?
Choice How much does your employee **currently** telecommute . . . ?
Permit How much **would you allow** your employee to telecommute . . . ?
Expect Six months from now, how much **do you expect** your employee to be telecommuting . . . ?

Table 3-23: Relative Telecommuting Frequency – Supervisor Responses[1]

After	Proportion of Work Week - Mean and Standard Deviation (N=28)			
	Job	Choice	Permit	Expect
From a center	32.3% (21.2)	28.3% (21.7)[2]	36.7% (22.3)	29.7% (22.9)
From home	18.3% (22.0)	5.6% (10.5)	18.0% (19.5)	7.6% (11.2)

[1] See Table 3-11 for the values used in the frequency calculation and Table 3-22 for the definition of the categories.
[2] N = 27

Home-based telecommuting was not perceived as positively as center-based telecommuting with respect to job suitability and permitted frequency: only 28.6% of the managers thought that the nature of the job allowed their employees to telecommute from home one to two days per week; 35.7% were willing for the employee to telecommute from home that often. About 61% of the

managers reported that their employees did not telecommute from home currently, and 46.3% of the managers did not expect their employees to be telecommuting from home within the next six months. The results are consistent with prior hypotheses that center-based telecommuting could be superior to home-based telecommuting in terms of job suitability and manager acceptance (e.g., Bagley, *et al.*, 1994) but are at odds with other researchers' findings that telecenters are not viewed favorably by managers (Bernardino and Ben-Akiva, 1996). Clearly, the self-selection bias of this sample should be kept in mind when interpreting these results; that is, managers who are willing to participate in this project are more likely to have a positive view of telecenters than the general population of managers.

3.3.7 Summary of Manager Responses

This section summarizes the survey results from 28 supervisors of center-based telecommuters. On the whole, the respondents reported an optimistic and positive attitude toward telecommuting. The analysis showed clearly that supervisors' opinions of the performance of their employees did not diminish with the introduction of telecommuting.

Characteristics dealing with the workplace atmosphere (such as motivation, professional appearance, and distractions) were considered to be similar at both the regular workplace and the telecenter. Areas in which the center was perceived less positively than the regular workplace concerned the supervisor-employee relationship (such as communication, availability, professional interaction, and administrative burden) as well as security of information and property. However, mean ratings for the telecenter on these characteristics were all neutral or better, indicating that the disadvantage is relative, not absolute. These attitudes seem to be generic to telecommuting in general since they tended to be even less favorable for home-based telecommuting.

Nearly all of the managers (93%) indicated having a positive attitude toward telecommuting in general, and 82% rated their level of satisfaction with center-based telecommuting as high or very high. (However, a selection bias must be noted, as managers who were dissatisfied with telecommuting would be less likely to have lasted long enough to complete an after survey. As indicated in Section 5.3, supervisor-related concerns were cited by 5 of the 20 employees from whom reasons for quitting could be obtained as important reasons for quitting telecommuting). Six potential advantages were viewed by managers to be at least moderately significant following the introduction of center-based telecommuting: improved employee retention, improved ability to recruit employees, increased productivity, compliance with environmental regulation, improved employee relations, and (marginally) reduced absenteeism. However, from 11% to 21% of the managers reported "no opinion" on the four following potential advantages of telecommuting: improved ability to recruit employees, reduced health costs, compliance with environmental regulations, and improved disaster response capability. This suggests the need to raise awareness of the potential benefits of telecommuting in these areas.

It is an important result that the perceived advantages of telecommuting are those for which the benefit is difficult to quantify (customer service and productivity), while telecommuting is not perceived to offer advantages on "hard" money items such as office space and parking costs. This will continue to make center-based telecommuting difficult to justify in purely economic terms. Indeed, while 39% of the respondents indicated that the organization was likely to (continue to) offer center-based telecommuting, an equal proportion cited reduced costs, the

ability to quantify the benefits, and increased manager acceptance as factors that needed to change before the organization would be likely to offer center-based telecommuting.

About half of the managers expected that more of the organization's workforce would be telecommuting from a center in the future. However, from one-sixth to one-third of the organizations themselves did not have official opinions on various potential advantages of telecommuting according to the respondents. When opinions by the management levels above the supervisors were expressed, they tended to be less positive than those of the supervisors. Indeed, it appears that some managers are supporting telecommuting for their staff in the face of actively negative attitudes on the part of upper management. This suggests the need for upper-level management to have increased exposure to the benefits of telecommuting.

Although the employees performed well at the telecenter or even better than they did at the regular workplace in some aspects, managers still preferred telecommuting to be a part-time alternative for their employees. Very few managers expected their employees to be telecommuting from the center full-time. The managers' average ideal distribution of work time for their employees included nearly 64% at the regular workplace and 29% for center-based telecommuting. The current and the expected future telecommuting frequencies of 30% (which is equivalent to 1.5 days per week) are consistent with the managers' ideal work time distribution. However, in the managers' perception, the appropriate telecommuting frequency for their employees was more constrained by job suitability (32% of work time on average) than by the managers' willingness (37%). In any case, the managers still feel that the regular workplace is the primary work location, to be used three or more days out of the work week.

Home-based telecommuting was not perceived as positively as center-based telecommuting with respect to job suitability and permitted frequency, although the self-selection bias of the sample must be taken into account in interpreting this result. The managers were willing for the employees to telecommute nearly three times as often from the center as from home. Also, some mixture of center and home-based telecommuting was considered ideal by nearly one-third of the managers.

This expectation of part-time telecommuting may act to inhibit the adoption of telecommuting centers. If employees are only using the center one or two days per week, there may be little opportunity for their space at the regular workplace to be used for other purposes. If an organization must continue to offer the same amount of space at the regular workplace as before, plus pay rent on space at the telecenter, other telecommuting advantages will have to be that much stronger to compensate for the added cost.

3.4 Comparison of Employee and Manager Results

As can be seen from the preceding sections, the employee and manager surveys were designed such that the responses to certain questions could be compared between the two groups. These questions include job performance and satisfaction, attitudes about work environment characteristics, and the amount of telecommuting. However, the results of the comparison of telecenter employee and manager survey results must be viewed with some caution. Although future analysis may match up each telecenter user with his/her supervisor, this has not yet been done since the sample size is small (there are only 19 employee-manager pairs in the after telecenter data set analyzed for this interim report). So the comparison presented here shows only

the group averages for those who returned surveys. In addition, the comparison group sizes vary considerably: 39 telecenter users and 28 managers (see Table 3-1). Therefore, variations in survey responses between the two groups may be due in part to not having completely matched responses, as well as to the differing perspectives of employees and their specific managers.

3.4.1 Job Performance and Satisfaction

Similar questions were asked of both the employees and the managers about employee job performance and job satisfaction. For the characteristics of job performance, two comparisons can be made between the employee and manager results (see Table 3-24). A direct comparison of the average employee's assessment of his/her performance and the average manager's assessment shows only slight differences. A somewhat unusual result is that for two of the four factors, the managers gave a higher average rating than the employees. In fact, the greatest average difference is for the ability to meet deadlines where employees rated themselves lower than the managers did. An additional comparison can be made between the employee's opinion of the supervisor's assessment and the supervisor's assessment. Again, there are only slight variations between the two averages for each factor; however, the values are generally closer together than in the first comparison. The exception is the "ability to meet deadlines" factor mentioned previously. It appears that employees perceive meeting deadlines to be more of a problem after the start of telecenter use than their managers do.

Table 3-24: Comparison of Job Performance

Question	Rating (Mean and Standard Deviation)		
	Employees (N = 39)		Managers (N = 28)
	Assessment	Supervisor's Assessment	Assessment
Amount of work completed	4.26 (0.59)	4.30 (0.78)	4.32 (0.77)
Quality of work	4.44 (0.55)	4.33 (0.78)	4.36 (0.73)
Ability to meet deadlines	4.18 (0.79)	4.16 (0.83)	4.32 (0.72)
Overall productivity	4.36 (0.63)	4.24 (0.80)	4.29 (0.76)

The majority of the average ratings on the factors of job satisfaction are also similar between both telecenter users and managers of telecenter users (see Table 3-25). However, three factors show notable differences. First, managers were more likely to be satisfied with the availability of resources for completing tasks than employees were. Second, employees were more bothered by client demands on their time than managers were. These two results are not particularly startling given that employees must deal with these problems more often than their supervisors have to. Surprisingly, employees had a higher average rating for the supervisor showing appreciation than the supervisors had. Perhaps supervisors preceive that they need to work at this part of their job more than they actually need to.

Table 3-25: Comparison of Job Satisfaction

Question	Rating (Mean and Standard Deviation)	
	Employees (N = 39)	Managers (N = 28)
Supervisor/employee communication[3]	4.16 (1.03)	4.32 (0.48)
No lack of resources for employee[1]	3.54 (1.21)	4.11 (0.63)
Employee's work team is effective	3.85 (0.84)	4.04 (0.66)
Work well with supervisor/employee	4.08 (0.94)	4.21 (0.69)
Supervisor shows appreciation for employee[1]	4.05 (0.83)	3.14 (1.04)
Employee works well with co-workers[1]	4.49 (0.88)	4.32 (0.67)
Confidence in employee's ability to do the job	4.51 (0.56)	4.54 (0.51)
Likelihood of employee to stay at the job[1]	3.82 (1.07)	3.71 (0.76)
Employee works well with those supervised[2]	3.93 (0.96)	3.85 (0.69)
Client demands on employee's time[1, 3]	3.46 (0.93)	3.12 (0.85)

[1] Responses were negatively worded on the survey, but changed to a positive orientation for comparison with other responses.
[2] N = 15 for employees and N = 13 for managers.
[3] N = 24 for employees and N = 24 for managers.

3.4.2 Work Environment Characteristics

Both the employee and manager versions of the survey contain a section about work environment characteristics. These two sections have 15 questions in common. The mean rating for each part of these questions are shown in Figure A-1 of Appendix A and Figure C-1 of Appendix C. Rather than discuss the differences in the 45 means, this section will focus on a comparison of the ANOVA results.

An analysis of variance was conducted for each set of work characteristic questions to determine if the response for each question differs significantly between the three work locations: the regular workplace, the telecommuting center, and home (see Sections 3.2.4 and 3.3.4). The p-values from the employee and manager ANOVAs are shown in Table 3-26. For most of the questions, both employees and managers had significantly different means for the workplace locations. However, for three questions, managers did not have significantly different means although the employees did. Managers did not perceive any locational difference for the employee overeating or indulging in other ways, working while sick or disabled, and the employee's scheduling freedom. These factors are admittedly more important to employees and may not be recognized as advantages or disadvantages of telecommuting by managers. Another factor, supervisor communication, was only marginally significant for the employee data but was very significant for the manager data. Again, managers are perhaps more concerned with

communication than employees and, as a result, have more concerns with communication at remote work locations.

Table 3-26: Comparison of ANOVA Results

Question	P-values[1]	
	Employees (N=117)	Managers (N=84)
Easy to be motivated	**.000**	**.010**
Supervisor uncomfortable[2]	**.000**	**.017**
Professional appearance	**.000**	**.000**
Distractions from others	**.000**	**.000**
Overeat or indulge	**.000**	.768
Relative independence	**.000**	.102
Good for the environment	**.000**	**.023**
Not visible to management[2]	**.000**	**.000**
Not have needed equipment	**.000**	**.000**
Work while sick or disabled[3]	**.000**	.326
Scheduling freedom	**.004**	.133
Work judged by results	.955	.364
No professional interaction	**.000**	**.000**
Supervisor communication[4]	.111	**.000**
Work effectively[5]	**.000**	.018

[1] The sample sizes are 117 and 84 for employees and managers respectively (three times the number of respondents), since each question is asked once for each of the three workplaces. Bolded p-values are significant at $\alpha \leq 0.05$.

[2] N = 114 for employees.

[3] N = 115 for employees.

[4] N = 108 for employees.

[5] N = 111 for employees.

3.4.3 Amount of Telecommuting

Perhaps not surprisingly, employees and managers have different ideal distributions of the work time. Although both groups chose the regular workplace as the most frequent worksite, telecenter users allocated only 44.6%, while managers assigned 63% of the work time. The telecommuting center received a much higher percentage, on average, from the employees (41.5%) than the managers (29%) which suggests that managers restrict the employees from telecommuting as much as they would like. Home had somewhat similar proportions of work time at 8.6% from employees and 10% from managers, respectively. Finally, the percentage of time assigned to other locations varies substantially between groups (5.4% from employees and 14% from

managers). This last difference is likely the result of the non-matching samples rather than a preference by the employees to work less at other locations since some employees have more tasks at other locations than other employees.

The ideal distribution responses also give the combination of workplaces preferred by respondents (see Table 3-27). The two most popular work arrangements are the same for both employees and managers. Working at the regular workplace and telecenter is the most popular arrangement (41% and 57% for employees and managers, respectively) and working at home in addition to the previous two locations is the second most popular option (23% and 25%). Although the arrangement of regular workplace, telecenter, and other location was a frequently-preferred option for employees (13%), only one manager preferred this arrangement for his/her employee.

Table 3-27: Comparison of the Distribution of Workplace Combinations

Workplace Combination[1]	Employees (N = 39)	Managers (N = 28)
RW/TC	16 (41.0%)	16 (57.1%)
RW/TC/HM	9 (23.1%)	7 (25.0%)
RW/TC/OL	5 (12.8%)	1 (3.6%)
ALL	2 (5.1%)	1 (3.6%)
TC/HM	2 (5.1%)	1 (3.6%)
RW	0	1 (3.6%)
RW/HM	1 (2.6%)	0
TC	1 (2.6%)	1 (3.6%)
TC/HM/OL	1 (2.6%)	0
Missing	2 (5.1%)	0

[1] Workplace locations are the regular workplace (RW), the telecommuting center (TC), home (HM), and other location (OL).

The relative telecommuting frequency for various categories can also be compared between employees and supervisors. The data presented in Table 3-28 reprint the telecommuting frequencies listed and described in Tables 3-11 and 3-23. The average manager and employee responses for telecommuting from a center are similar for all questions except the first. Managers said that the nature of the job would only allow working at the telecenter for 32% of the time, while employees felt that 41% of the time was suitable for telecenter use. For home-based telecommuting, however, the average frequencies of the supervisors were lower than those of the telecenter users for all categories. So, while it seems that these supervisors have embraced telecommuting from a center, they are still somewhat hesitant to approve telecommuting from home.

Table 3-28: Comparison of Relative Telecommuting Frequency

Question[1]	Proportion of Work Week - Mean and Standard Deviation			
	Employees (N = 39)		Managers (N = 28)	
	From a Center	From Home	From a Center	From Home
Job	40.5% (29.0)	26.6% (27.6)	32.3% (21.2)	18.3% (22.0)
Supervisor/Choice	40.8% (30.7)[2]	27.0% (31.1)[2]	36.7% (22.3)	18.0% (19.5)
Choice/Permit	29.9% (28.1)	9.6% (21.4)[2]	28.3% (21.7)[3]	5.6% (10.5)
Prefer	50.4% (27.2)	20.0% (26.4)[2]	---	---
Expect	33.1% (26.4)	11.7% (23.3)[4]	29.7% (22.9)	7.6% (11.2)

[1] See Table 3-11 and 3-22 for the text of the survey questions.
[2] N = 38 [3] N = 27 [4] N = 37

3.4.4 Summary of Employee-Manager Comparison

The comparison of similar questions from the employee and manager surveys is constrained by the limited sample sizes in the interim data set. The data compared in this section are overall group means rather than matched employee-manager results. Consequently, the differences in means may be due to the mismatch between groups rather than to the differences between employees and their particular managers.

Not surprisingly, the preferred amount of telecommuting differs between employees and managers. On average, employees would ideally work less of their time at the regular workplace (44.6%) and more at the telecommuting center (41.5%) than managers would prefer them to (63% and 29% at the regular workplace and telecenter, respectively). Working at the main office and the telecenter proved to be the most preferred combination of workplaces for both groups. Importantly, employees believed that the nature of the job allowed for about 40% telecommuting from a center, while managers said only 32% of time was suitable, on average. Although some of the telecommuting frequency averages are similar for employees and managers, the managers select lower telecommuting amounts when there are substantial differences between the two.

Responses for similar job performance and satisfaction questions and the results of analyses of variance for similar work environment characteristics questions were mostly similar for both study groups. Surprisingly, on some job performance factors, employees rated themselves lower than the managers did. The three job satisfaction factors that had sizeable differences were resource availability, client demands, and supervisor appreciation. Employees were less satisfied with the first two job factors and more satisfied on the last factor than the managers were.

CHAPTER 4

TELECOMMUTING PATTERNS

4. TELECOMMUTING PATTERNS

4.1 Introduction

Though many studies have examined attitudes toward telecommuting, preference for telecommuting (Mokhtarian and Salomon, 1997; Stanek, 1995; Bagley, 1995), choice of telecommuting (Mokhtarian and Salomon, 1996; Bernardino, *et al.*, 1993; Mahmassani, *et al.*, 1993), and characteristics of telecommuters (Hartman, *et al.*, 1991; Yap and Tng, 1990), few studies to date have attempted to explore patterns of telecommuting behavior in detail. Questions of interest include how often individuals telecommute, the duration of their telecommuting participation, how much time they spend at the telecenter, and how they distribute their time over various work locations on a given day.

It is useful to analyze these types of questions both at the disaggregate and aggregate levels. At the disaggregate level, analyzing telecommuting behavior provides further insight into individual choice patterns, and offers the potential for building models to explain and predict those choices. On the aggregate (site specific and all sites combined) level, such an analysis will support the evaluation of the centers' operational performance, the development of marketing strategies, and the recruitment of participants.

The following section discusses data collection and cleaning procedures. Section 4.3 presents the aggregate analysis of telecommuting patterns, including: utilization of the telecenter, work time spent at the telecenter, workplace combinations on telecommuting days, and mode of travel to the telecenter. Section 4.4 offers a disaggregate analysis of telecommuting patterns, including telecommuting duration, telecommuting frequency, proportion of telecenter-only working days, and mode choice to the telecenter. Section 4.5 summarizes the key findings of the chapter.

4.2 Data Collection and Cleaning

4.2.1 Data Collection

The information was collected at the telecenters participating in the project. Telecommuters were instructed to make an entry in the attendance log each day they used the telecenter. The entry included date, name, transportation mode used to get to the telecenter, and estimated work time to be spent at various workplaces, including telecenter, main office, home, and any other work location. An example attendance log sheet is found in Appendix G.

To the extent participants forgot or declined to sign in at each use, these data may somewhat undercount the usage of the telecenter by telecommuters. However, site administrators had an incentive to ensure the most accurate reporting possible, as occupancy levels were calculated based on the sign-in data and each site had a contractual obligation to meet certain occupancy levels (see the companion volume on telecenter operation). In addition, other uses of each telecenter occurred which were not captured by the attendance log (see Section 2.3).

For this interim report, only sign-in data through June 30, 1995 were analyzed (for Davis and Anaheim, no data were available after January and March 1995, respectively). An additional year of sign-in data (through June 30, 1996) will be available for analysis in the final report.

Table 4-1 lists the availability of attendance log data at the RABO and non-RABO telecenters that provided attendance data. A majority of the data comes from the two non-RABO sites since they have been operating for a longer period. The data availability according to each site is shown in Table 4-2. The information from the telecenter in Ontario dominates the overall data with 46.7% of all telecommuting occasions. More than half of the information gathered at RABO sites comes from the telecenters in Coronado, Grass Valley, Modesto, and Chula Vista. The amount of data produced by each site depends on (1) the operating length of the center, (2) the number of telecommuters, and (3) the frequency of use by each telecommuter.

Table 4-1: Data Availability

Group	Number of Occasions[1]	Number of Users	Number of Workstations
RABO Sites	2371 (36.0%)	116	94
Non-RABO Sites	4206 (64.0%)	175	30 (24[2])
Total	6577 (100%)	291	124 (118[2])

[1] Denotes total number of person-day telecommuting occasions.
[2] At the Ontario center, the number of workstations decreased by six on March 1, 1994.

4.2.2 Data Cleaning

Each telecommuter was expected to sign in once for each telecommuting occasion. However, even after correcting data entry errors, double entries in the data set occurred due to the following reasons: (1) the telecommuter signed in twice on the same day (this may be the result of the telecommuter returning to the telecenter later in the day and forgetting that s/he had signed in already) or (2) the telecommuter attended two different telecenters on the same day.

Several rules were defined to process these unusual cases:

- If the two entries made on the same day by an individual were identical, one of them was eliminated. In the original data set, 26 cases (0.4% of RABO and non-RABO cases combined) fell into this category.
- If the two attendance log entries were for the same telecenter and different from each other, the one with the longer work time spent at the telecenter was preserved. It is assumed that the longer duration was the sum of work time for the two visits. Three such cases were found in the original data set.
- For the occasions on which a telecommuter signed in at two different telecenters on the same day, both records were preserved for aggregate analyses of measures such as site occupancy rate. However, for the disaggregate analysis of indicators such as telecommuting frequency, the one with longer time spent at the telecenter was selected. Six of these cases were found.

Some entries in the data set are missing. The non-RABO sites of Highland and Ontario did not begin using the attendance logs designed by this project until February 1, 1994 and September 1, 1994, respectively. Prior to these dates, those sites obtained sign-in and sign-out times for each

Table 4-2: Data Availability by Site

Site	Start Date	End Date	Number of Weeks	Number of Occasions[1]	Number of Users	Number of Workstations
Coronado	11/01/93	06/30/95	86.6	278 (4.2%)	15	4
Grass Valley	02/08/94	06/30/95	72.4	515 (7.8%)	10	6
Anaheim	06/30/94	03/01/95	34.9	108 (1.6%)	10	15
Vacaville - Ulatis	08/01/94	06/30/95	47.6	230 (3.5%)	25	7
Davis	08/11/94	01/12/95	22.0	15 (0.2%)	4	10
Vacaville - Alamo	08/15/94	06/30/95	45.6	231 (3.5%)	20	8
Chula Vista - H St.	09/19/94	06/30/95	40.6	410 (6.2%)	15	10
Modesto	10/18/94	06/30/95	36.4	235 (3.6%)	10	10
Chula Vista - F St.	11/01/94	06/30/95	34.4	166 (2.5%)	7	8
Ventura Community College	02/01/95	06/30/95	21.3	87 (1.3%)	3	5
La Mesa	03/07/95	06/30/95	16.4	36 (0.5%)	5	6
Moorpark Community College	04/17/95	06/30/95	10.6	60 (0.9%)	2	5
Ontario	11/27/91	06/30/95	187.3	3071 (46.7%)	157	24 (18[2])
Highland	12/08/92	06/30/95	133.4	1135 (17.3%)	18	6
Total				5577 (100%)	291[3]	124 (118[2])

[1] Denotes total number of person-day telecommuting occasions.
[2] Eighteen workstations were available after March 1, 1994.
[3] Denotes total number of individuals: 9 telecommuters attended both of the Vacaville telecenters and 1 telecommuter attended both of the Chula Vista telecenters. They are counted under each site but not double-counted in the total.

telecommuter but did not request information on transportation mode used to get to the telecenter nor on the distribution of work time at locations other than the telecenter. Thus, this information was not available for 2774 (66%) of the 4206 telecommuting occasions recorded in Table 4-1. Among these 4206 occasions, even the information on work time at the telecenter was missing for 1566 cases (37.2%).

Among the 2371 entries from RABO sites, the information associated with transportation mode and distribution of work time was missing for 65 (2.7%) and 23 (1.0%) of the cases, respectively. Among the 1432 entries from non-RABO sites using the attendance logs designed for this project, the information about transportation mode and distribution of work time was missing for 132 (9.2%) and 134 (9.4%) of the cases, respectively. The amount of missing data associated with the information for each site is shown in Table 4-3. Finally, attendance logs for some months are missing from some telecenters because the site administrators failed to provide the information: specifically August 1993 for Ontario, January 1994 for Highland, and September and October 1994 for Davis. No attempt was made to estimate the number of telecommuting occasions or any other information for these months.

Table 4-3: Proportion of Missing Information for Each Site

Site	N[1]	Work Time	Travel Modes
Highland	776	5.4%	10.4%
Ontario	656	14.0%	7.8%
Coronado	278	1.4%	2.2%
Grass Valley	515	0	2.7%
Anaheim	108	0	2.8%
Vacaville - Ulatis	230	3.0%	1.7%
Davis	15	0	0
Vacaville - Alamo	231	1.3%	7.5%
Chula Vista - H St.	410	1.2%	2.7%
Modesto	235	0.4%	3.4%
Chula Vista - F St.	166	0.6%	1.2%
Ventura Community College	87	0	0
La Mesa	36	0	0
Moorpark Community College	60	0	0

[1] N is the total number of telecommuting occasions.

4.3 Aggregate Analysis

In this section, aggregate telecommuting patterns both across all sites combined and by each site separately are presented. The following four sections respectively discuss utilization of the telecenter, work time spent at the telecenter, workplace combinations on telecommuting days, and means of travel to the telecenter.

4.3.1 Utilization of the Telecenter

To evaluate the operational performance of telecenters, one must develop a method to express how the facilities were utilized. The total number of telecommuting occasions is not an adequate measure because the telecenters are of different sizes. Thus, the largest number of occasions is likely to occur at the telecenters equipped with the most work stations. To control for differing sizes, two measures of telecenter utilization, the usage rate and the occupancy rate, were developed.

The monthly telecenter usage rate is the total number of occasions (person-days) on which the center was used for telecommuting, divided by the product of the number of work stations and the number of working days in the month:

$$\text{usage rate} = \frac{\text{number of telecommuting occasions}}{\text{number of workstations x number of work days}} . \qquad (4.1)$$

The monthly telecenter occupancy rate is calculated as the number of telecommuting occasions that are at least four hours long divided by the same denominator:

$$\text{occupancy rate} = \frac{\text{number of telecommuting occasions of at least 4 hours}}{\text{number of workstations x number of work days}} . \qquad (4.2)$$

That is, the usage rate is the proportion of "workspace-days" for which the center was used for any length of time (for telecommuting), and the occupancy rate is the proportion of workspace-days for which it was occupied at least four hours. These formulas draw on the concepts of exposure as used in accident studies. The denominator in equation 4.1 could be interpreted as the total number of possible opportunities for telecommuters to be exposed to the telecenter.

The total number of working days is adopted instead of the total number of days in the month because we are focusing on telecommuting as a substitution for commuting to the office on a normal working day. For the purposes of this analysis, "working days" excludes Saturdays, Sundays and eight federal holidays (New Year's Day, Martin Luther King's Birthday, President's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas). For the aggregate analysis presented here in Section 4.3, if the initial observation for a *center* did not coincide with the first day of the month, only working days from the first telecommuting occasion onward were included in the usage and occupancy rates calculated for that first month of operation. For the disaggregate analysis presented in Section 4.4, if the initial observation for an *individual* did not coincide with the first day of the month, only working days from the first telecommuting occasion onward were included in the corresponding calculation for that individual.

Figure 4-1 shows the average usage and occupancy rates across all RABO sites, from the opening of the first site (Coronado) in November 1993 through June 1995, the cutoff point for analysis for this interim report. The trend varies considerably over time. Several reasons make it difficult to explain or predict the variation. First, the telecenters opened at different times. Since a center will typically open with relatively low usage and then build up over time, entry of a new site into the calculation tends to depress the average. (The bottom line on Figure 4-1 indicates how many sites were open each month, that is, the number of sites over which the average rates were calculated). Further, the size of each center also affects usage and occupancy rates. Fifty telecommuting occasions in a week would represent 100% usage for a 10-workstation site, but only 50% usage for a site with 20 workstations. Finally, the rates also change according to the number of telecommuters at the site in that month, as well as the number of their telecommuting occasions. Some telecommuters quit telecommuting, some newly joined, and some did not telecommute during certain months.

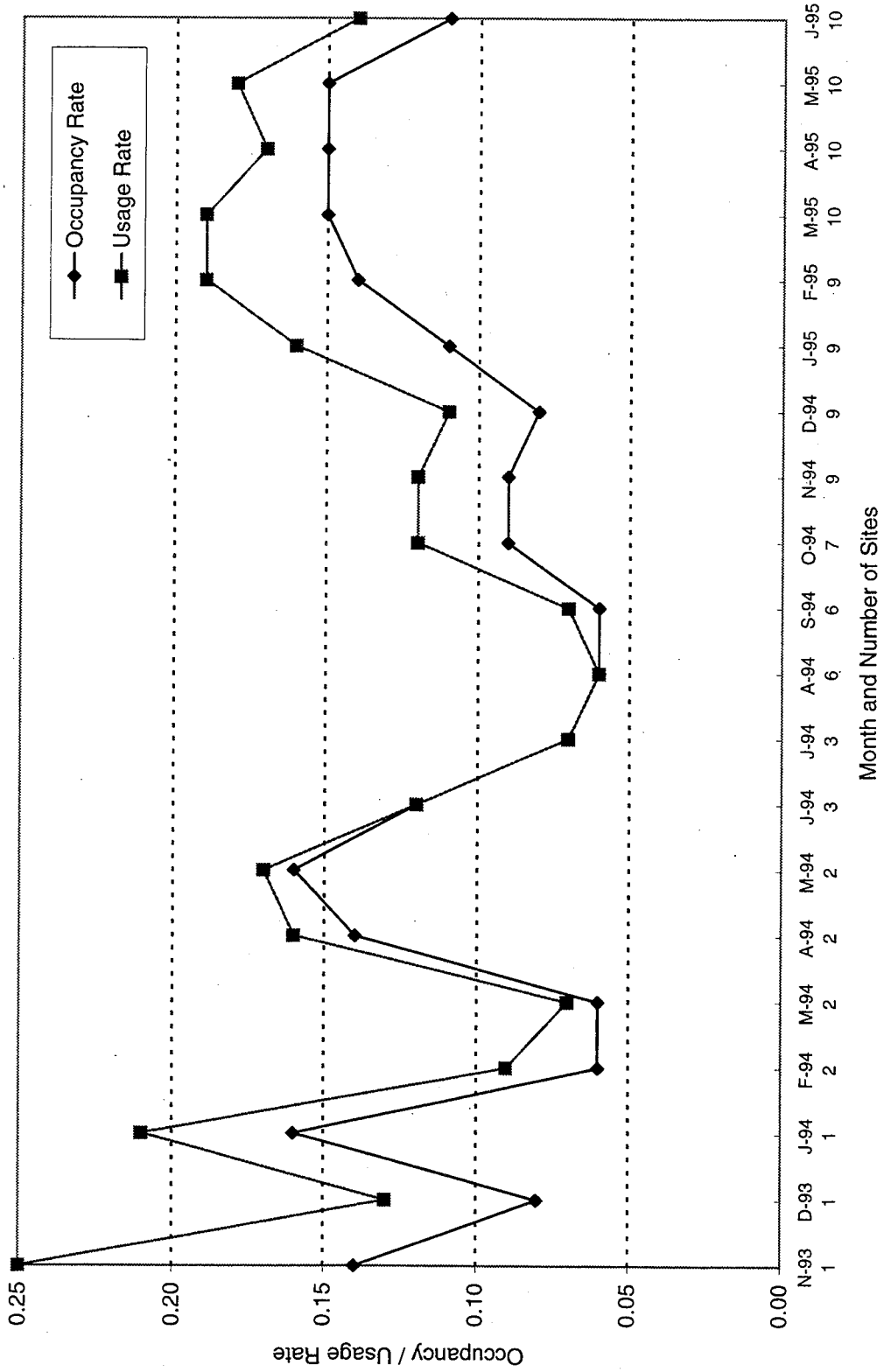
In spite of these factors, a couple of tentative observations may be made. First, the rates appear to have stabilized somewhat for the last 6 months of observation: January 1995 to June 1995. The average usage rates ranged between 15 and 20%. The occupancy rates were somewhat lower ranging from 10 to 15%. Secondly, there does appear to be a seasonal effect, specifically a "summer slump". The dip in the summer of 1994 is partially confounded by the entry of four new sites, but the trend (based on only two sites) appears to have pre-dated those new openings. Summer 1995 data are not analyzed for this report, but Figure 4-1 seems to indicate a coming dip based on the June 1995 data point. It will be important to combine these data with the additional year of operation that will be available for the final report in order to solidify these conclusions.

To control for the confounding factor of sites opening at different times, average usage and occupancy rates were computed based on the number of months a site had been open. Note, however, that this introduces the confounding factor of seasonality. That is, the summer and winter holiday seasons will occur after a differing number of months of operation for each center, so it would not be easy to separate out those effects. The only way to control for both start-up and seasonal effects would be to extend the time period of observation well past the point at which start-up effects would be negligible for all sites and then look at the average rates on a calendar-month basis as in Figure 4-1.

Figure 4-2 shows the average usage and occupancy rates for the first 10 months of operation across all RABO sites. The average usage rate begins at 9% in the first month of operation and rises to 16% after 10 months; the average occupancy rate rises from 9 to 12% over the same period. The trends show slow but steady growth in the utilization of the telecenters. However, as shown in Figure 4-3, the individual usage rates demonstrate significant variation not only between sites but also at each site.

Figure 4-4 shows the usage rates at non-RABO sites. The center in Ontario maintained roughly steady usage rates between 10 to 20%. In contrast, Highland had a relatively high utilization, especially over the last few months of observation (from 40 to 62%). However, this relatively high usage was due to (1) the small number of workstations (six) compared to Ontario (24 or 18); and (2) the fact that several telecommuters, including a real estate agent, used the center nearly every day. Obviously, the usage rate is a function of the number of the workstations at the center and number of person-day telecommuting occasions.

Figure 4-1 : Occupancy and Usage Rates at RABO Sites



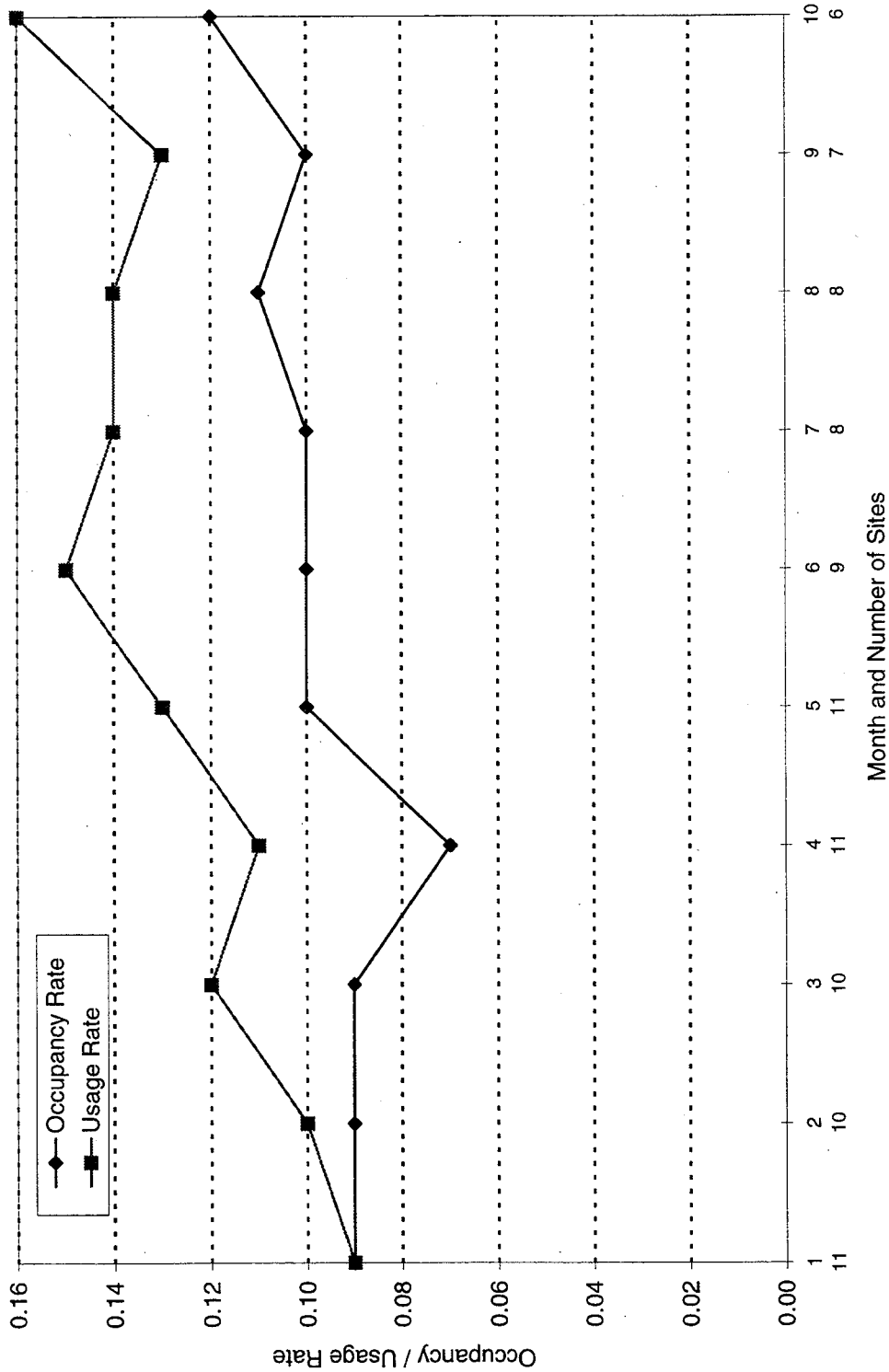


Figure 4-2: Occupancy and Usage Rates for the First 10 Months of Operation at RABO Sites

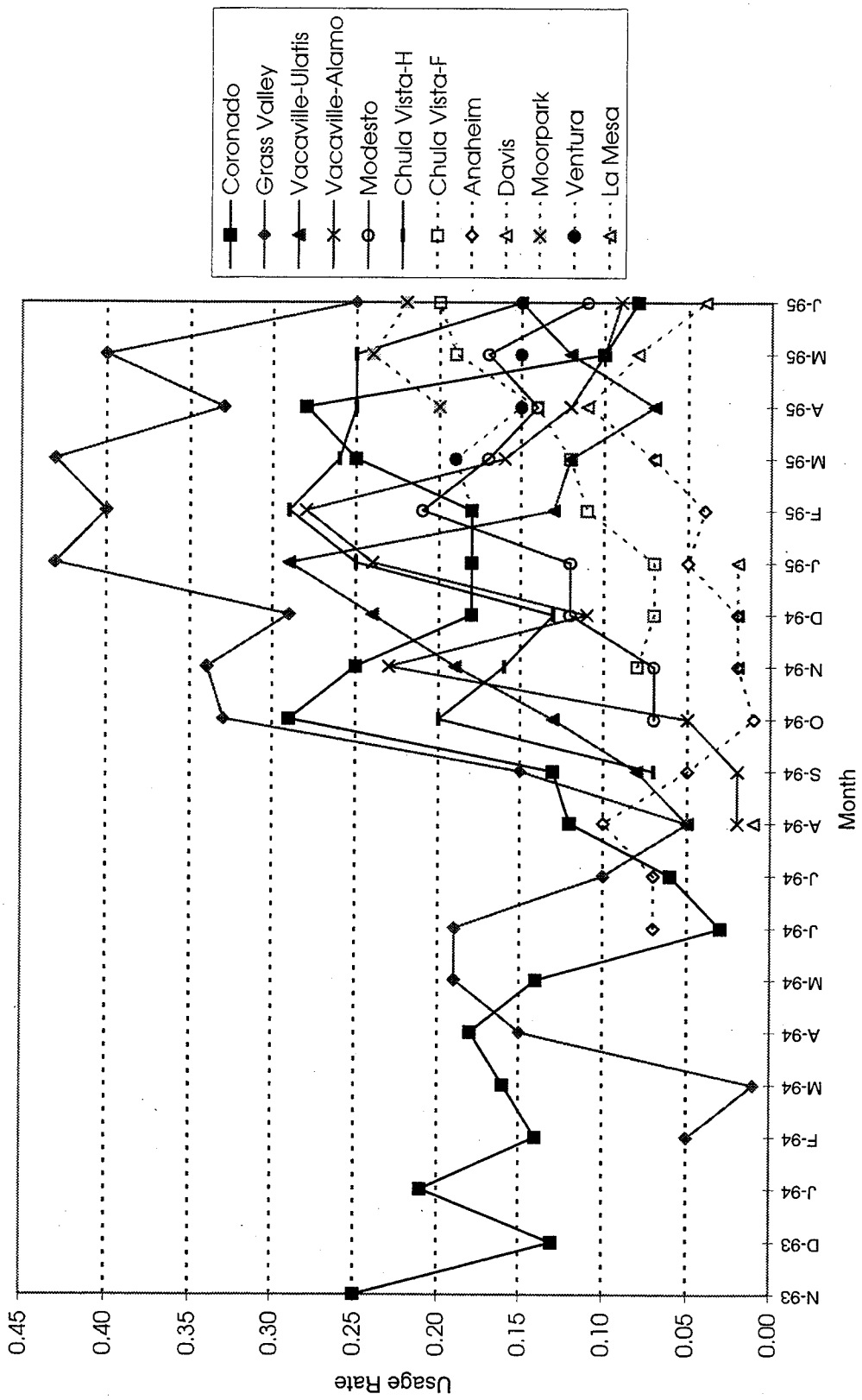


Figure 4-3: Usage Rates at Each RABO Site

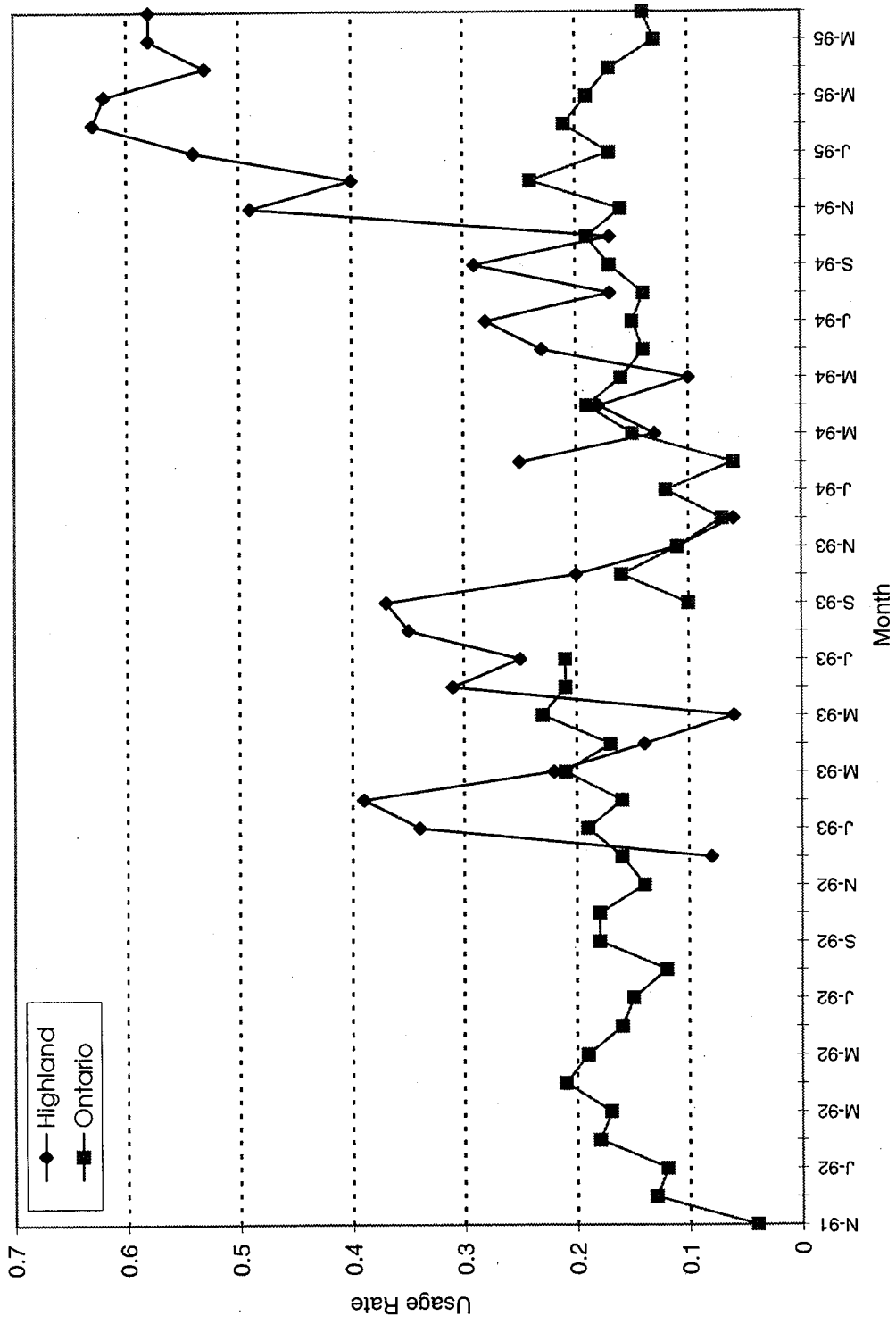


Figure 4-4: Usage Rates at Each Non-RABO Site

4.3.2 Work Time Spent at the Telecenter

On each telecommuting occasion, telecommuters reported how long they worked at the telecenter. The average work time for RABO telecenter users was 5.73 hours, with a standard deviation of 2.72 hours. Non-RABO telecenter users stayed at the telecenter for 6.73 hours on average, with a standard deviation of 2.83 hours. Under a test for equality of means, the two average work times were statistically different ($p \approx 0.000$).

Figure 4-5 illustrates the distribution of reported work time spent at the telecenter. For the RABO sites, peaks appear at 3-4 hours and 7-8 hours. These peaks reflect the tendency to spend either half a day or a full day at the telecenter. About 56% of the occasions fell into these two categories. Nearly 51% of the telecommuting occasions lasted 6 hours or longer. Although 37.2% of the information was missing for non-RABO sites, the available data show that the telecommuters were likely to work only at the telecenter on their telecommuting days. Figure 4-6 shows the cumulative distribution of the work time spent at the telecenter for both RABO and non-RABO sites based on the available data. A χ^2 test shows that the two work time distributions are significantly different ($p \approx 0.000$), with RABO sites showing a higher proportion of shorter telecommuting occasions.

4.3.3 Workplace Combinations on Telecommuting Days

On telecommuting days, it is possible that the telecommuters worked at more than one location, such as the regular workplace (RW), home (HM), and other locations (OL) as well as the telecenter (TC). To better understand how the telecenter is used, it is desirable to analyze the frequency of various workplace combinations. Eight combinations are possible: (1) TC only, (2) TC/RW, (3) TC/HM, (4)TC/OL, (5) TC/RW/HM, (6) TC/RW/OL, (7) TC/HM/OL, and (8) TC/RW/HM/OL.

Figure 4-7 shows the distribution of telecommuting occasions for each of the eight workplace combinations at RABO sites and non-RABO sites. At RABO sites, the most common patterns are (1) TC only (59.8%), (2) TC/OL (14.9%), and (3) TC/HM (9.3%). For the combinations involving the center and one or more other locations, 10.6% of all RABO telecommuting occasions involved working from the regular workplace, 16.8% involved working at home, and 23.9% involved working from another location. Overall, only 10.4% of RABO occasions involved working at more than two locations.

Working solely at the telecenter was by far the most frequent telecommuting pattern at non-RABO sites (85.1%). The second and third most common workplace combinations were TC/OL (8.7%) and TC/RW (4.1%), respectively. Contrary to expectation, telecommuting from a center is not often combined with home-based telecommuting in the same day. Although many participants state they wish to engage in both home-based and center-based telecommuting to some degree (see Section 3.2.4), apparently any particular day is more likely to see one or the other forms of telecommuting exclusively. However, telecenter/home combinations are common for the five users of the newer sites in Moorpark and Ventura. Therefore, the aggregate pattern may change with a longer operating history for those two sites.

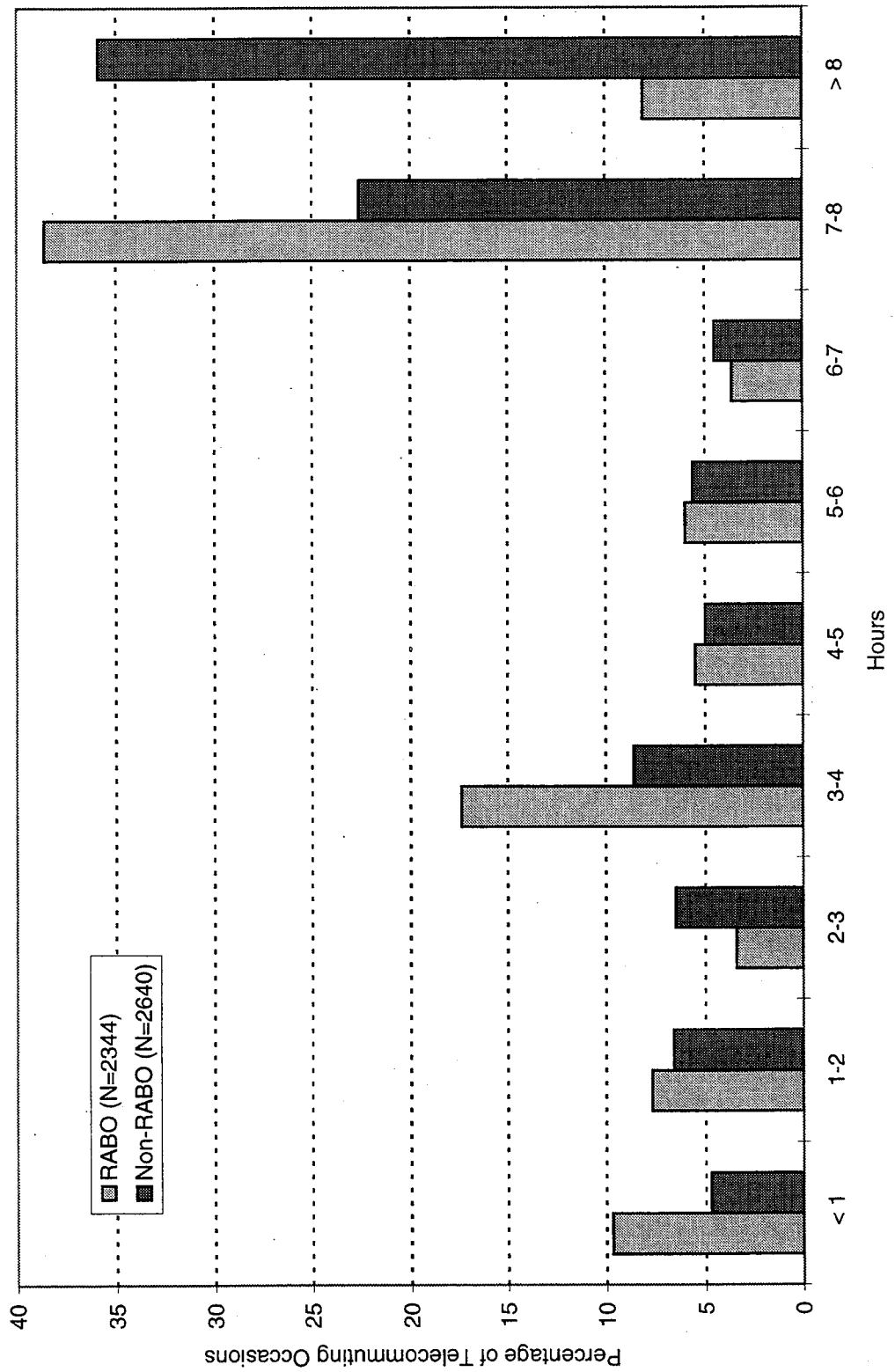
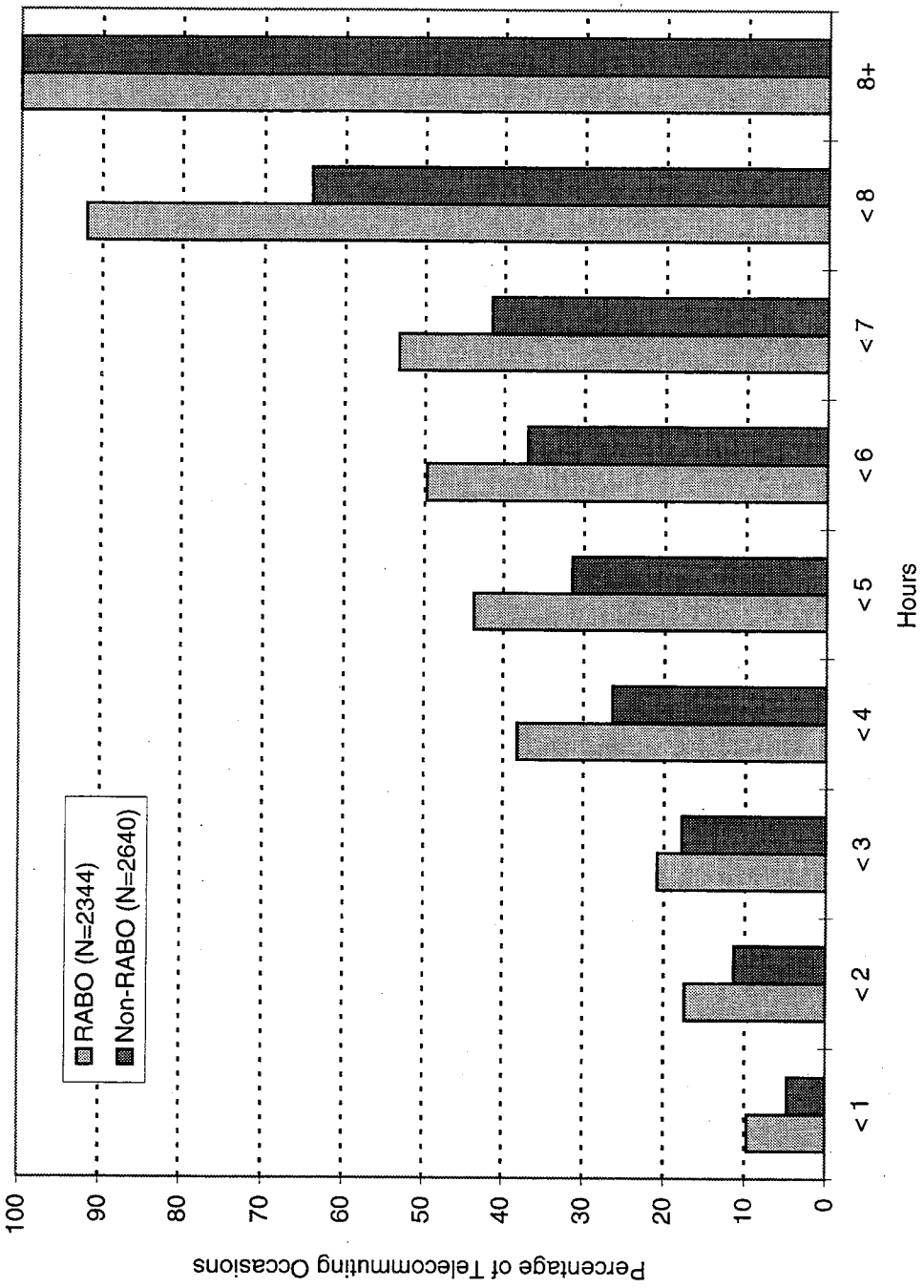


Figure 4-5: Distribution of Work Time Spent at the Telecenter

Figure 4-6: Cumulative Distribution of Work Time Spent at the Telecenter



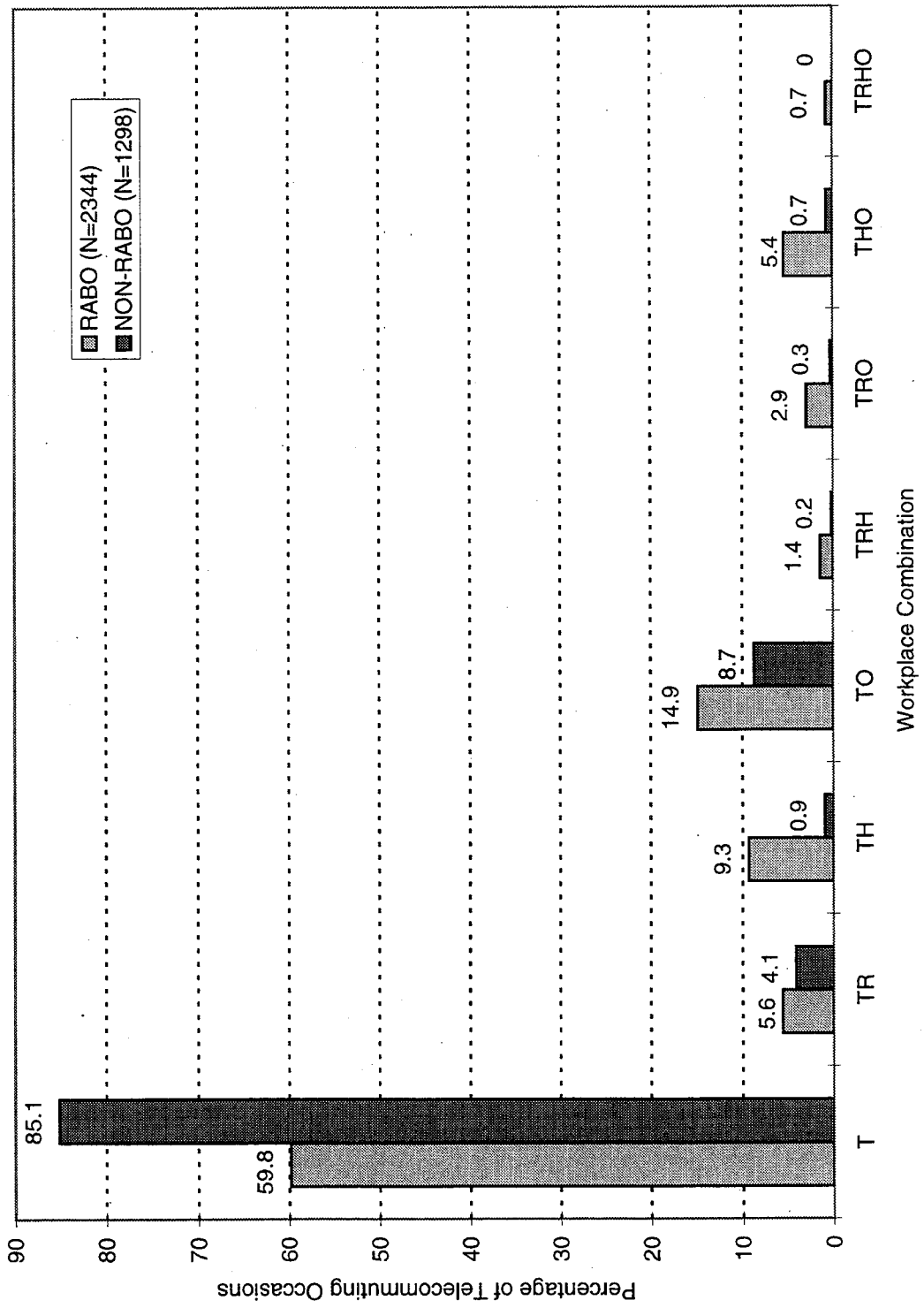


Figure 4-7: Distribution of Workplace Combinations on Telecommuting Days
(T=telecenter, R=regular workplace, H=home, O=other location)

The average work time distributed by workplace combination for RABO and non-RABO sites is presented in Tables 4-4 and 4-5, respectively. The findings for the most common combinations can be summarized as follows.

- On average, nearly 7 hours were spent at the center if the telecenter was the only work location used that day.
- If the telecommuters worked at the center and at an "other" location (TC/OL), the work time spent at the telecenter dropped to about 3.5 hours on average. More work time was spent at the other workplace than at the telecenter. It is likely that the telecommuters' main task on that day was to work at the other location. They may have gone to the telecenter to prepare for or finish that main task.

Table 4-6 shows that the distribution of telecommuting occasions for the eight workplace combinations varies considerably across sites. Except for Alamo, a plurality of the telecommuting occasions at each site was telecenter-only; this was the majority pattern at eight of the fourteen sites. Working at the telecenter and an other location (TC/OL) was popular at Ulatis, Alamo, and Chula Vista (H St.). This is in keeping with the use of the Ulatis and Alamo sites by several health care workers, who spent part of the day rendering services at patients' homes.

The TC/HM pattern was common at Coronado, Moorpark Community College, and Ventura Community College. The TC/RW and TC/HM/OL patterns were fairly popular at Anaheim and at Chula Vista (F St.), respectively. The variation in workplace combinations among sites is likely the result of the diverse job characteristics of telecommuters.

At non-RABO sites, the telecenter-only pattern dominates the sample, occurring on about 85% of the occasions. The TC/OL and TC/RW are the second most common patterns at Highland and at Ontario, respectively.

4.3.4 Travel Modes for Accessing the Telecenter

Table 4-7 depicts the distribution of the primary transportation mode used to access RABO and non-RABO telecenters. For more than three-fourths of the telecommuting occasions (77.1%) at RABO sites, telecommuters drove alone to the telecenter. Other common travel modes were being dropped off (7.3%), carpooling (6.0%), and walking/biking (5.6%). On 0.9% of the occasions, an alternative-fuel vehicle was used (most of these trips were made to the Moorpark site). Clearly, driving alone was the primary means of commuting to RABO sites.

The utilization of transportation modes at non-RABO sites is similar to that at RABO sites. Driving alone was even more common for non-RABO sites (89.2%) than for RABO sites. Thus, placing telecenters near residential areas may have had a marginal effect on lowering the share of drive-alone access trips. However, driving alone remained the dominant mode in both cases. For a more extensive discussion of the transportation impacts of telecenters, see Chapter 6.

Although participants drove alone a majority of the time at each site, the proportion of drive-alone occasions varied from 57.7% to 98.2%, and each site had a somewhat different mode distribution. Other popular modes include walking/biking at Coronado (24.5%) and Davis (26.7%), carpooling at Alamo (29.9%) and Anaheim (21.9%), alternative-fuel vehicle (28.3%)

Table 4-4: Work Time Spent at Each Workplace for Various Combinations (RABO Sites)

Workplace Combination	Number (Proportion)	Hours (Mean and Standard Deviation)			
		Telecenter	Regular Workplace	Home	Other Location
TC	1402 (59.8%)	6.92 (2.41)	---	---	---
TC/RW	131 (5.6%)	4.44 (1.89)	3.84 (1.79)	---	---
TC/HM	218 (9.3%)	5.25 (2.08)	---	2.98 (1.62)	---
TC/OL	349 (14.9%)	3.53 (2.16)	---	---	4.73 (2.14)
TC/RW/HM	32 (1.4%)	3.34 (1.60)	3.20 (1.95)	2.05 (1.22)	---
TC/RW/OL	69 (2.9%)	2.58 (1.63)	2.61 (1.53)	---	3.48 (2.14)
TC/HM/OL	126 (5.4%)	3.55 (1.45)	---	1.66 (1.04)	2.82 (2.08)
ALL	17 (0.7%)	2.46 (1.57)	1.26 (0.53)	1.53 (0.78)	3.91 (2.45)
Total RABO	2344	5.73 (2.72)	0.34 (1.16)	0.41 (1.10)	0.99 (2.08)

Table 4-5: Work Time Spent at Each Workplace for Various Combinations (Non-RABO Sites and Overall)

Workplace Combination	Number (Proportion)[1]	Hours (Mean and Standard Deviation)			
		Telecenter	Regular Workplace	Home	Other Location
TC	1105 (85.1%)	6.75 (2.46)	---	---	---
TC/RW	53 (4.1%)	3.25 (1.68)	5.53 (1.67)	---	---
TC/HM	12 (0.9%)	5.50 (1.83)	---	2.67 (1.15)	---
TC/OL	113 (8.7%)	3.92 (1.82)	---	---	4.73 (1.81)
TC/RW/HM	2 (0.2%)	5.50 (0.71)	1.50 (0.71)	1.00 (0.00)	---
TC/RW/OL	4 (0.3%)	3.25 (0.96)	3.25 (1.89)	---	3.50 (3.32)
TC/HM/OL	9 (0.7%)	4.56 (2.07)	---	1.56 (1.01)	3.00 (1.00)
ALL	0 (0.0%)	---	---	---	---
Total Non-RABO	1298	6.32 (2.59)	0.24 (1.16)	0.04 (0.32)	0.44 (1.47)
Total RABO	2344	5.73 (2.72)	0.34 (1.16)	0.41 (1.10)	0.99 (2.08)
Total	3642	5.94 (2.69)	0.31 (1.16)	0.27 (0.92)	0.80 (1.91)

[1] The proportion is based on data from the non-RABO sites only.

Table 4-6: Distribution of Workplace Usage by Each Site[1]

Site	N[2]	Workplace Combination[3]							
		TC	TC/RW	TC/HM	TC/OL	TC/RW/HM	TC/RW/OL	TC/HM/OL	ALL
Coronado	274	**63.9%**	4.4%	*19.7%*	3.6%	3.6%	3.6%	1.1%	0
Grass Valley	515	**85.4%**	4.3%	*5.6%*	2.3%	0	1.0%	0.2%	0
Anaheim	108	**68.2%**	*22.4%*	0.9%	7.5%	0.9%	0	0	0
Vacaville - Ulatis	223	**46.6%**	2.2%	3.6%	*37.2%*	0	4.0%	2.2%	4.0%
Davis	15	**86.7%**	*6.7%*	*6.7%*	0	0	0	0	0
Vacaville - Alamo	228	*32.5%*	0	3.9%	**39.0%**	0.4%	7.0%	15.4%	1.8%
Chula Vista - H St.	405	**36.0%**	13.1%	11.1%	*27.2%*	1.7%	4.9%	5.7%	0.2%
Modesto	234	**96.6%**	0	*2.6%*	0	0	0	0.9%	0
Chula Vista - F St.	165	**38.8%**	1.2%	15.2%	9.7%	1.2%	1.2%	*31.5%*	1.2%
Ventura	87	**39.1%**	12.6%	*24.1%*	3.4%	5.7%	8.0%	5.7%	1.1%
La Mesa	36	**82.9%**	2.9%	0	*14.3%*	0	0	0	0
Moorpark	60	**43.3%**	0	*31.7%*	25.0%	0	0	0	0
Highland	734	**83.7%**	1.4%	1.0%	*12.4%*	0	0.3%	1.2%	0
Ontario	564	**87.1%**	*7.4%*	0.9%	3.9%	0.4%	0.4%	0	0
All Sites	3648[4]	**68.9%**	5.0%	6.3%	*12.7%*	0.9%	2.0%	3.7%	0.5%

[1] The most frequent combination for each site is bolded, and the second most frequent is italicized and underlined.
[2] N is the number of telecommuting occasions.
[3] Workplace locations are the regular workplace (RW), the telecommuting center (TC), home (HM), and other location (OL).
[4] This number differs from the total of Table 4-5 in that 6 occasions involved both Vacaville sites and are here counted under both sites.

Table 4-7: Distribution of Travel Modes for Accessing Each Telecenter[1]

Site	N	Walk/ Bike	Alt.-Fuel Vehicle	Drive Alone	Carpool	Public Transit	Dropped Off	Other Mode
Coronado	272	*24.6%*	1.1%	**57.7%**	12.9%	0.4%	2.6%	0.7%
Grass Valley	501	4.4%	0	**72.1%**	0.2%	0.2%	*23.2%*	0
Anaheim	105	0	0	**77.1%**	*21.9%*	0	1.0%	0
Vacaville - Ulatis	226	0.9%	0	**95.6%**	*3.5%*	0	0	0
Davis	15	*26.7%*	0	**73.3%**	0	0	0	0
Vacaville - Alamo	214	5.1%	0	**65.0%**	*29.9%*	0	0	0
Chula Vista - H St.	399	0	0.3%	**97.0%**	0.8%	0	*2.0%*	0
Modesto	227	*9.7%*	0	**87.7%**	0.4%	0	2.9%	0
Chula Vista - F St.	164	0	0	**98.2%**	*1.8%*	0	0	0
Ventura	87	0	0	**62.1%**	0	0	*37.9%*	0
La Mesa	36	8.3%	0	**72.2%**	8.3%	*11.1%*	0	0
Moorpark	60	0	*28.3%*	**71.7%**	0	0	0	0
RABO Total	2306	5.7%	0.9%	**79.5%**	6.1%	0.3%	*7.4%*	0.1%
Ontario	605	1.0%	0	**79.7%**	*17.0%*	0.3%	1.8%	0.2%
Highland	695	0.3%	0	**97.6%**	0.4%	0	*1.7%*	0
Non-RABO Total	1300	0.6%	0	**89.2%**	*8.2%*	0.2%	1.8%	0.1%
Total	3606	3.9%	0.6%	**83.1%**	*6.8%*	0.2%	5.4%	0.1%

[1] The most frequent combination for each row is bolded, and the second most frequent is italicized and underlined.

Although participants drove alone a majority of the time at each site, the proportion of drive-alone occasions varied from 57.7% to 98.2%, and each site had a somewhat different mode distribution. Other popular modes include walking/biking at Coronado (24.5%) and Davis (26.7%), carpooling at Alamo (29.9%) and Anaheim (21.9%), alternative-fuel vehicle (28.3%) at Moorpark Community College, and being dropped off at Grass Valley (23.2%) and Ventura Community College (37.9%).

However, it should be understood that the observed patterns are a function of the telecommuting frequency of individuals and the total number of individuals at each site. For example, two telecommuters were using the telecenter located at Moorpark Community College, and one of them commuted to the telecenter in an alternative-fuel vehicle. If this telecommuter were to telecommute more often, a higher utilization of this mode would result. This result does not imply that more people utilized that mode. Therefore, the mode distribution by sites only conveys information on what modes the telecommuters used and how many telecommuting occasions were made by that mode. The mode choice behavior of the individual telecommuter is discussed in Section 4.4.4.

4.4 Disaggregate Analysis

In the aggregate analysis, average telecommuting patterns for each center and across all telecenters were presented. The patterns are based on the pool of all telecommuting occasions considered together. Those who telecommute more often will have a disproportionate effect on the overall pattern, as their occasions appear more frequently in the pool. As a result, the aggregate patterns may not represent the behavior of an average telecommuter. To gain a better understanding of individual telecommuting behavior, the analysis reported in this section was performed on a person-by-person basis.

The study of telecommuting duration and frequency is fundamentally important to our understanding of the adoption of telecommuting and, hence, the impacts of telecommuting on travel and related issues. We may successfully predict that a certain number of individuals will telecommute. But if we falsely assume that they will telecommute in perpetuity (when in fact they, say, telecommute in a one-year-on, two-year-off cycle), and/or if we assume that they will telecommute (hypothetically) one day per week when the average is close to once every two weeks, we will greatly overestimate the number of people telecommuting on any given day and the associated travel-related impacts. The attendance log data collected for this study offers a unique opportunity to study these important questions, as well as other aspects of the telecommuting patterns of individuals.

The five disaggregate indicators analyzed here include individual telecommuting duration, telecommuting frequency, proportion of telecenter-only working days, work time spent at the telecenter, and proportion of drive-alone telecommuting days. However, not every individual in the data set was appropriate to include in the individual analyses. For 24 (20.7%) of the individuals at RABO sites and 45 (25.7%) at non-RABO sites, frequency and duration could not be meaningfully computed. These participants either telecommuted

- once only (13.8% at RABO sites; 20.6% at non-RABO sites),
- twice only, with less than two weeks between the two occasions (6.9% at RABO sites; 5.1% at non-RABO sites), or
- twice only, with more than a year between the two occasions (one user at a non-RABO site).

Some of these 69 individuals were new entrants to the program who had not had a chance to telecommute more often by the June 30, 1995 cutoff date, and others may have been drop-in users who were not expected to be regular telecommuters. However, at least 12 of these people were registered program participants who dropped out after one or two telecommuting occasions (participants who quit the program are discussed further in Chapter 5).

These 69 one- and two-time telecommuters were excluded from all disaggregate analyses. (Other participants who only telecommuted twice were retained and will appear with relatively short duration and/or frequency in the subsequent sections). The remaining 92 telecommuters at RABO sites and 130 individuals at non-RABO sites comprise the sample population of 2365 telecommuting occasions for the disaggregate analysis of telecommuting duration and frequency.

For the analysis of the individual proportion of telecenter-only working days, proportion of drive-alone telecommuting days, and work time, the information is based on the 92 telecommuters from RABO sites only. Non-RABO telecommuters are excluded because information was unavailable for many cases. The information on travel mode and work time distribution at multiple locations was unavailable for 70 (53.9%) of the non-RABO users because they stopped telecommuting prior to February 1, 1994 at Highland and September 1, 1994 at Ontario, the dates on which the attendance log designed by this project was introduced (see Appendix G). Only 25 (19.2%) non-RABO telecommuters had provided complete information on the five indicators listed above, and the other 35 (26.9%) individuals had provided partial information.

4.4.1 Telecommuting Duration

This section analyzes the length of time over which individuals telecommute from a center, or their telecommuting duration. We assume that there is no missing attendance information, that is, that each telecommuter signed in properly on each telecommuting day. For RABO sites, administrators had a vested interest in ensuring completeness of the sign-in records, as they were contractually obligated to maintain certain occupancy targets (see the companion volume on telecenter operation). Thus, while there are doubtless some missing data, it is reasonable to believe that they constitute a relatively small proportion of the whole. For the purposes of calculating telecommuting duration, it is assumed that no left-censoring of the data occurs, that is, that the individual had not been telecommuting prior to the first recorded use of the center. In other words, it is assumed that the first use of the center coincides with the start of telecommuting.

There is a difficulty, however, in similarly assuming that the last attendance date is the day the individual quit telecommuting. If this were the case, all telecommuters would be considered to have quit using the telecenter on or before June 30, 1995 (the last day in the interim report data set). In reality, of course, some participants will have quit before June 30 and others will not have. Since most of the participants did not telecommute every working day, or even with a constant frequency, it is difficult to determine whether a telecommuter had quit the program or was simply between uses of the telecenter.

Two decision rules were utilized to identify the status of the telecommuters as either quitters or stayers: one based on the existence of an exit interview and the other based on average length of time between telecommuting occasions. The telecommuters who were known to have stopped telecommuting were asked to participate in an exit interview as a part of this project. Those who

completed an exit interview were easily identified as quitters (see Chapter 5). For the rest of the telecenter users, a rule was devised to define their telecommuting status. If the period of time from the last telecommuting date to the cutoff date for inclusion in the interim report (June 30, 1995) was more than three times the average length of time between two successive telecommuting occasions for that person, the telecommuter was regarded as a quitter. Otherwise, s/he was a stayer, meaning that the actual exit time-point had not yet been observed for that individual. Thus, the telecommuting durations of stayers are right-censored. Although arbitrary, using three time the average period between telecommuting occasions as the basis for a decision rule is based on the concern that the telecenter users may reduce their telecommuting frequency but still remain in the program. Nevertheless, applying this rule runs some risk of falsely classifying as stayers people who quit telecommuting shortly before June 30, as well as a risk of misclassification in the opposite direction.

Therefore, the definition of telecommuting duration is based on whether the telecommuter is a quitter or stayer. For quitters, the last day of telecommuting is considered to be the date of their final attendance log entry. However, stayers are considered to be telecommuting up to the cutoff date of June 30, 1995 instead of up to the last recorded day of telecommuting. For example, if a stayer's last recorded telecommuting occasion before the cutoff date was on June 21, 1995, the duration is counted from the first telecommuting date to June 30, 1995. In addition, the duration is rounded down to the nearest month. For example, if an individual telecommuted for 3.8 months, s/he is classified as a stayer for the first three months and as a quitter for the fourth month.

Telecommuting duration here is similar to the survival time of an individual in a conventional medical study: those who quit telecommuting are analogous to the patients who die and the stayers are analogous to those who are living at the end of the observation period. The data possess two features which correspond to the characteristics of survival data. First, telecommuting duration is not symmetrically distributed: some telecenter users quit within a very short time but some continue to telecommute for more than three years (at non-RABO sites). Second, as discussed above, the telecommuting duration is frequently right-censored.

The ratio between quitters and stayers is of importance to the analysis. If the right-censored observations (stayers) outnumber the uncensored ones (quitters), the statistical techniques associated with failure time data may not be appropriate for this study. Of the 222 individuals (92 at RABO sites and 130 at non-RABO sites) considered, 47 of the RABO telecenter users (51.1%) and 99 non-RABO users (76.2%) stopped telecommuting on or before the June 30, 1995 cutoff date. This proportion of quitters is considered acceptable for the use of conventional failure time analysis techniques. The following is a summary of the model formulation drawn from Miller (1981), Cox and Oakes (1984), and Collett (1994).

A basic element in the analysis of telecommuting duration is the survival function. The survival function is defined as the proportion of telecenter users telecommuting beyond time t:

$$\hat{S}(t) = \frac{\text{number of telecenter users telecommuting longer than } t \text{ months}}{\text{total number of telecenter users}}. \qquad (4.3)$$

Suppose that there are n telecommuters for whom telecommuting durations are observed. Some of these observations are right-censored, and there is also more than one telecommuter with the

same observed exit time. Therefore, suppose there are r exit times among the individuals, where $r \leq n$. Then these exit times are arranged in ascending order: $t_{(1)} < t_{(2)} < \ldots < t_{(r)}$. The probability of surviving at a specific time $t_{(j)}$ given that the individual has already survived past time $t_{(j-1)}$ could be estimated as

$$P(t_{(j)}) = \text{Prob}(T \geq t_{(j)} \mid T > t_{(j-1)}) = \frac{n_j - q_j}{n_j}, \tag{4.4}$$

where T is the observed telecommuting duration, n_j is the number of individuals who were still telecommuting just before $t_{(j)}$ and q_j is the number of individuals who quit in the time interval $[t_{(j)}, t_{(j+1)})$.

The number of telecommuters n_j is governed by the equation

$$n_j = n_{j-1} - q_{j-1} - c_{j-1}, \tag{4.5}$$

where c_{j-1} is the number of censored observations in the time interval $[t_{(j)}, t_{(j+1)})$. The status of observations that are censored at time $t_{(j-1)}$ cannot be determined for later times, and hence these censored observations must be removed from the number of people n_j known to be telecommuting at times $t_{(j)}$ and later.

Suppose the exit times of telecommuters are assumed to occur independently. A series of time intervals can be constructed based on the observed exit times of the telecommuters. The cumulative probability of surviving beyond the kth exit time is the product of these k interval-specific survival probabilities:

$$\begin{aligned}
\hat{S}(t_{(k)}) &= \text{Prob}(T \geq t_{(k)}) \\
&= \text{Prob}(T \geq t_{(k-1)}, T \geq t_{(k)}) \\
&= \text{Prob}(T \geq t_{(k)} \mid T \geq t_{(k-1)}) \times \text{Prob}(T \geq t_{(k-1)}) \\
&= P(t_{(k)}) \times \hat{S}(t_{(k-1)}) \\
&= P(t_{(k)}) \times P(t_{(k-1)}) \times \ldots \times P(t_{(1)}) \\
&= \prod_{j=1}^{k} P(t_{(j)}) \\
&= \prod_{j=1}^{k} \frac{n_j - q_j}{n_j}.
\end{aligned} \tag{4.6}$$

Tables 4-8 and 4-9 illustrate the estimated survival functions for the telecommuters at RABO sites and non-RABO sites, respectively. These functions indicate the probabilities that an individual continues to telecommute after each time interval. From Table 4-8, for example, the probability of telecommuting beyond six months (through the six intervals) is

$$\begin{aligned}\hat{S}(t_{(6)}) &= P(t_{(1)}) \times P(t_{(2)}) \times P(t_{(3)}) \times P(t_{(4)}) \times P(t_{(5)}) \times P(t_{(6)}) \\ &= (0.9239)(0.8889)(0.9000)(0.8966)(0.9167)(0.8974) \\ &= 0.5451 .\end{aligned} \tag{4.7}$$

Table 4-8: Estimated Survival Function for RABO Telecommuters

Telecommuting Duration (months) j	Initial Number n_j	Number of Quitters q_j	Number of Censored Observations c_j	Conditional Probability of Surviving Beyond $t_{(j)}$ $P(t_{(j)})$	Cumulative Probability of Surviving Beyond $t_{(j)}$
0 - 1	92	0	0	1.000	1.000
1 - 2	92	7	4	0.924	0.924
2 - 3	81	9	2	0.889	0.821
3 - 4	70	7	5	0.900	0.739
4 - 5	58	6	4	0.897	0.663
5 - 6	48	4	5	0.917	0.607
6 - 7	39	4	3	0.897	0.545
7 - 8	32	2	5	0.938	0.511
8 - 9	25	3	3	0.880	0.450
9 - 10	19	1	4	0.947	0.426
10 - 15	14	2	8	0.857	0.365
15 - 19	4	1	1	0.750	0.274
19+	2	1	1	0.500	0.137

Table 4-9: Estimated Survival Function for Non-RABO Telecommuters

Telecommuting Duration (months) j	Initial Number n_j	Number of Quitters q_j	Number of Censored Observations c_j	Conditional Probability of Surviving Beyond $t_{(j)}$ $P(t_{(j)})$	Cumulative Probability of Surviving Beyond $t_{(j)}$
0 - 1	130	0	0	1.000	1.000
1 - 2	130	6	0	0.954	0.954
2 - 3	124	11	1	0.911	0.869
3 - 4	112	5	1	0.955	0.830
4 - 5	106	10	0	0.906	0.752
5 - 6	96	13	2	0.865	0.650
6 - 7	81	6	0	0.926	0.602
7 - 8	75	4	2	0.947	0.570
8 - 9	69	5	1	0.928	0.529
9 - 10	63	6	1	0.905	0.478
10 - 11	56	4	2	0.929	0.444
11 - 12	50	3	0	0.940	0.418
12 - 15	47	2	4	0.957	0.400
15 - 16	41	1	1	0.976	0.390
16 - 18	39	3	1	0.923	0.360
18 - 19	35	2	0	0.943	0.339
19 - 20	33	2	0	0.939	0.319
20 - 21	31	1	0	0.968	0.309
21 - 23	30	2	0	0.933	0.288
23 - 24	28	2	0	0.929	0.267
24 - 25	26	2	1	0.923	0.247
25 - 26	23	2	2	0.913	0.225
26 - 31	19	2	4	0.895	0.202
31 - 32	13	1	2	0.923	0.186

Table 4-9: Estimated Survival Function for Non-RABO Telecommuters (Continued)

Telecommuting Duration (months) j	Initial Number n_j	Number of Quitters q_j	Number of Censored Observations c_j	Conditional Probability of Surviving Beyond $t_{(j)}$ $P(t_{(j)})$	Cumulative Probability of Surviving Beyond $t_{(j)}$
32 - 40	10	1	3	0.900	0.168
40 - 41	6	1	0	0.833	0.140
41 - 42	5	1	4	0.800	0.112
42+	4	1	3	0.750	0.084

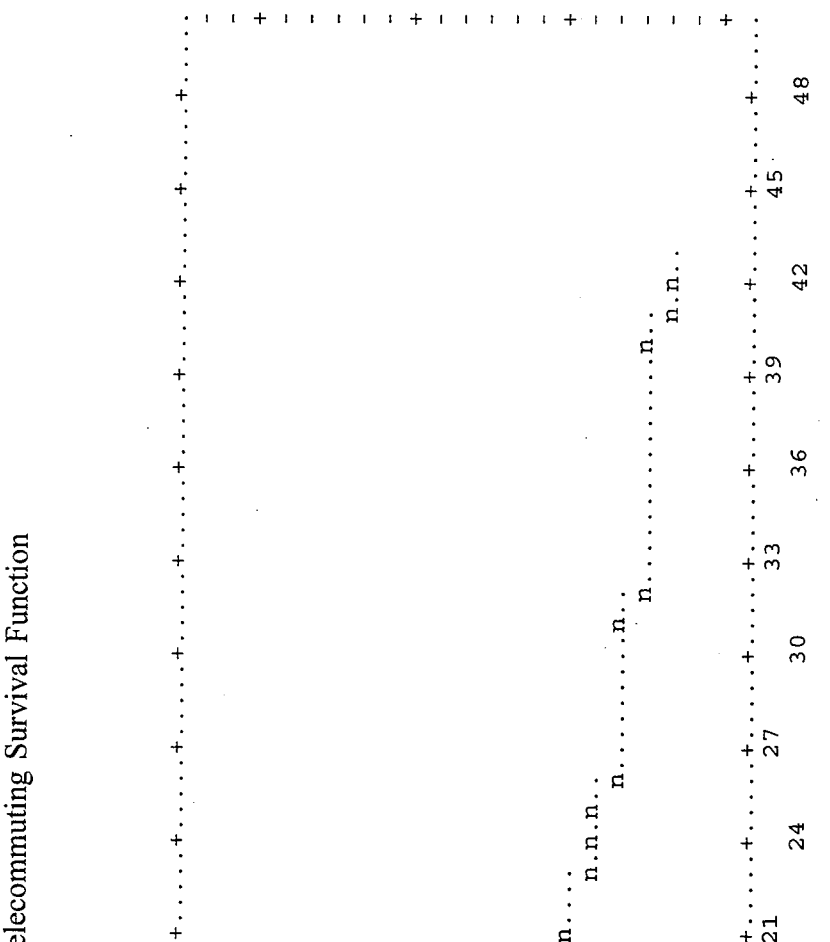
That is, there is a 54.5% chance that an individual will telecommute longer than six months. In a similar way, we can obtain a 27.4% chance of telecommuting more than 15 months. From the $P(t_{(j)})$ column of Table 4-8 it is seen, for example, that there is a 91.7% chance of continuing to telecommute past six months given that the individual has lasted five months. The graph of the estimated survival functions from BMDP software is shown in Figure 4-8. The estimated survival functions are constant between adjacent exit times and decrease at each exit time.

The median duration of telecommuting was 8 months at RABO sites and 9 months at non-RABO sites. This means that 50% of the participants telecommuted at least 8 and 9 months, respectively. Put negatively, it also means that half of the participants telecommuted at most 8 or 9 months. More than 25% of the RABO telecommuters telecommuted for at least a year, compared to 40% of non-RABO users. About 25% of the non-RABO telecommuters used the telecenter for at least two years. Despite the difference in telecommuting duration between RABO and non-RABO individuals, the two survival functions were not statistically different at a 0.10 level of significance. This means that at any time t, the estimated survival probability of telecommuting beyond t is statistically the same for telecommuters at both RABO and non-RABO sites. This result suggests that the operating length of the telecenter may not be an important factor in determining telecommuting duration. Rather, duration is probably a function of the characteristics of the individual telecommuter.

This relatively short median duration of telecommuting is an important finding. Few studies have collected data on attrition in telecommuting, so there is little to which to compare this figure. However, one study of home-based telecommuting reported an attrition rate of 33% within one year (Quaid and Lagerberg, 1992). Thus, these two studies suggest that attrition is higher for center-based telecommuting than for the home-based form, but further research is needed on this point.

Based on the analysis in this chapter, "once a telecommuter, always a telecommuter" is clearly not true. Reasons for quitting telecommuting are discussed in Chapter 5. In any case, later discussions of telecommuting frequency (Section 4.4.2) and of the travel impacts of telecommuting (Chapter 6) should be interpreted in the light of this information: that is, measured telecommuting frequencies and impacts may only be achieved for a relatively short period of time.

Figure 4-8: Telecommuting Survival Function



4.4.2 Telecommuting Frequency

In order to measure how often telecommuters used the telecenter, an individual's average telecommuting frequency is taken to be the ratio of the number of telecommuting days to the total number of working days during the duration of telecommuting. Again, this assumes no missing telecommuting occasions for each telecommuter. The number of working days includes the first and last telecenter visits but excludes Saturdays, Sundays, and eight federal holidays (see Section 4.3.4).

The frequency calculations were slightly modified to accommodate missing data at non-RABO sites. Data was missing for January 1994 at Highland and August 1993 at Ontario. The first and last telecommuting occasions could be used to judge whether the telecommuting duration included a missing month, but no information existed on specific telecommuting occasions. According to data from other months, 30 telecommuters may have telecommuted in those two months. For these cases, the number of working days in the missing month was subtracted from the total number of working days. Unless the telecommuting frequency for an individual was much higher or much lower than average during that month, the estimated frequency should be reliable.

Figure 4-9 shows the distribution of the average frequency of telecommuting for the 92 telecommuters at RABO sites and the 130 telecommuters at non-RABO sites. The cumulative distribution is shown in Figure 4-10. Since there are about 21 working days per month on average, a 5% telecommuting frequency is approximately equivalent to one telecommuting day per month. A 20% telecommuting frequency represents telecommuting once per week and 40% means twice per week. At RABO sites, about 9% of the telecommuters telecommuted on fewer than 5% of their working days. This implies that, for them, the average length of time between two telecommuting occasions was more than a month. More than half of the RABO telecommuters telecommuted less than one day per week, and about 22% telecommuted one to two days per week, on average.

The average telecommuting frequency at non-RABO sites (17.2%) was lower than that at RABO sites (25.0%). Nearly 21% telecommuted less than once per month on average. About 75% telecommuted less than one day per week. Although the low average frequency may reflect the real behavior of the telecommuters, the longer average telecommuting duration may be related to the low frequency. The longer period of observation at non-RABO sites may include a period of no telecommuting by the participants since some of the users were found to stop telecommuting for an extended period of time and then restart later on. Another possible explanation of the difference is that non-RABO site users may have been more likely not to sign in on occasions when they actually did use the center. Since non-RABO sites did not have the same contractual obligation to maintain target occupancy levels as the RABO sites did (see the companion volume on telecenter operation), they may not have rigorously enforced a policy of signing the attendance log on every occasion.

From the presentation of the average telecommuting frequency, it should not be inferred that telecommuters had a constant telecommuting frequency. The telecommuters are likely to have had several periods with different telecommuting frequencies during the entire duration of telecommuting. Therefore, the average frequency only reflects aggregate individual telecommuting behavior.

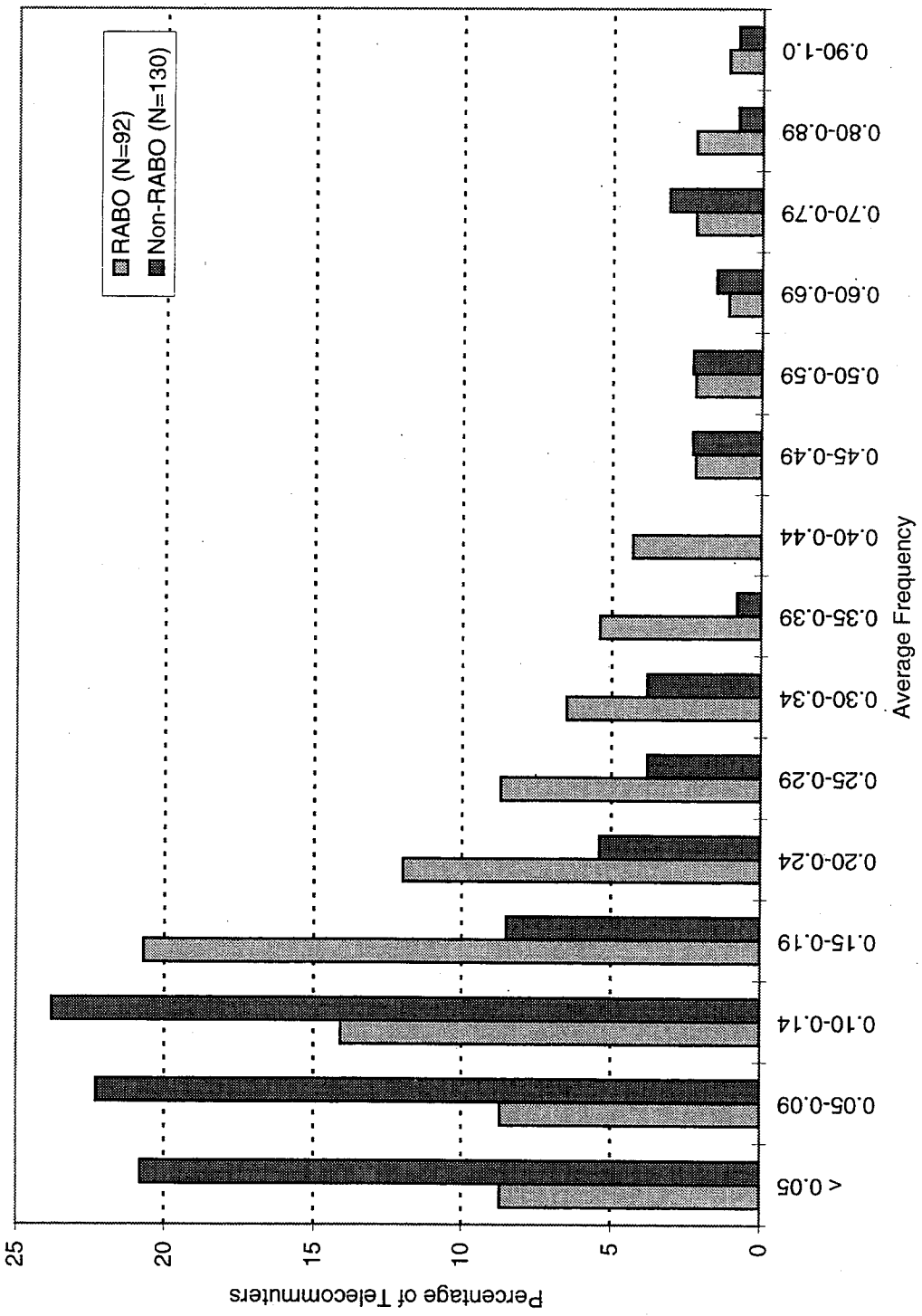


Figure 4-9: Distribution of Average Telecommuting Frequency

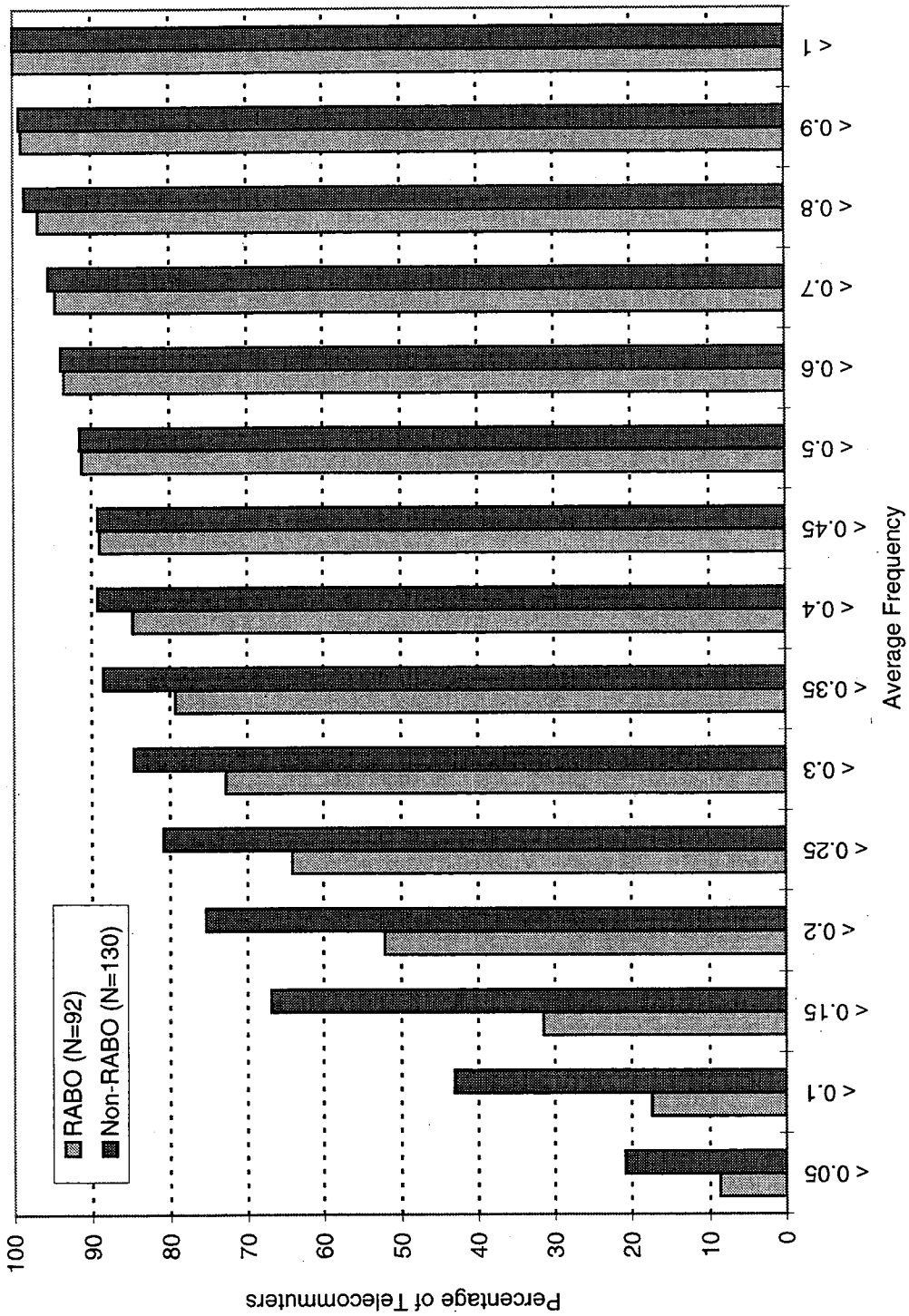


Figure 4-10: Cumulative Distribution of Average Telecommuting Frequency

4.4.3 Comparison of Different Measures of Telecommuting Frequency

The center-based telecommuting frequency for project participants may be estimated from two sources, namely, the after attitudinal surveys and the sign-in logs. The preceding section discussed the distribution of telecommuting frequencies based on the complete available sign-in log data for 92 RABO and 130 non-RABO telecommuters. Average frequencies of 25.0% for RABO sites and 17.2% for non-RABO sites were found, for telecommuting durations ranging from one to forty-three months. However, from the attitudinal survey data for the 39 RABO and non-RABO respondents who completed after surveys (Table 3-10 in Section 3.2.4), a "current" average telecommuting frequency of 29.9% was computed. This difference between data sources may be due to differences in the sample (those who completed the after survey may have been higher-frequency telecommuters), changes in the frequency of telecommuting over time, and/or a survey response bias.

We chose to explore further the third possibility, that of a survey response bias. In particular, it is of interest to obtain some insight into how respondents interpreted the attitudinal survey question (D11a, see Appendix E), "How much do you currently telecommute from a telecommuting center?" Since no specific time frame was given in the question, several interpretations are plausible. Respondents may have tended to report their most recent frequency (say, over the last month), an average frequency since the start of telecommuting, or some perceived "typical" frequency which may or may not relate to either of the previous possibilities. It is hypothesized that responses to the attitudinal survey will tend to overstate the actual amount of telecommuting. There may be a number of reasons for this, including the tendency to telescope less frequent events into a shorter time frame than the actual, a desire to increase the apparent success of the program, and "wishful thinking" – that is, a tendency to confound the actual frequency of telecommuting with a desired, perhaps an explicitly-stated, target frequency. To examine this hypothesis, the sign-in log data for the 39 attitudinal survey respondents was used to obtain the telecommuting frequency both during a one-month and a six-month window prior to the date on which the respondents filled out the after attitudinal surveys.

For the purposes of comparing these alternate measures of telecommuting frequency, a month was considered to have 22 working days. Holidays are disregarded, which means that the aggregate results discussed here slightly underestimate the frequency of telecommuting as a proportion of actual workdays. However, in reporting their telecommuting frequency as a general rate (for example, 1 to 2 days per week) in the attitudinal survey, it is unlikely that respondents precisely factored in the influence of holidays. In any case, the assumption is a convenient simplification, and as it is applied to all frequency measures equally, it should not affect the results of the comparison. Also, in calculating the average frequency from the attitudinal survey, the midpoint of the category checked was initially taken as the telecommuting frequency for that person (for example, the response category "about 1-3 days a month" was treated as a telecommuting frequency of 2/22, or 9.09%). The average frequencies obtained from the 39 attitudinal surveys and the corresponding sign-in log entries are shown below in the first three rows of Table 4-10.

As hypothesized, the highest measure of telecommuting frequency is obtained from the attitudinal survey: 30%, or 1½ days per week on average. The next highest measure is the one-month window from the sign-in log, showing an average 20% or one-day-per-week frequency. The six-month sign-in log measure is 18%, or 0.9 days per week. From a comparison of the two sign-in log averages it may appear that the telecommuting frequency is increasing over time, but the

difference is not statistically significant (t = 0.47; p-value = 0.644). However, the differences between AS and SIL6 (t = 2.16; p-value = 0.040), and between AS and SIL1 (t = 1.68; p-value = 0.100) are statistically significant (at $\alpha \leq 0.10$). Thus, initially the evidence seems to support the hypothesis that on the attitudinal survey, respondents overstate their actual telecommuting frequency as determined by the attendance log.

Table 4-10: Average Telecommuting Frequency

Source	Mean (S. D.)
Attitudinal survey (AS)	29.9% (28.1)
Six-month sign-in log (SIL6)	18.2% (18.7)
One-month sign-in log (SIL1)	20.4% (22.0)
Attitudinal survey (AS) [1]	23.4% (26.0)

[1] Using the lower bound rather than the midpoint of each category checked as the telecommuting frequency.

However, another potential cause for this result should be examined. It may be that the majority of the frequencies reported in the attitudinal survey actually fell in the lower half of the chosen categories. For example, in the "1-2 days a week" category, it is possible (even likely) that more respondents telecommute one day per week than two days per week. If this were true, then taking the midpoint of the interval as the average frequency for each category artificially inflated the overall average.

To further examine this potential cause of the observed results, the lower bound rather than the center of the interval was taken as the representative value for each category in the attitudinal survey, and the telecommuting frequency average was re-calculated. Now, if the obtained average were still significantly different from the averages obtained from SIL1 and SIL6, then a reasonable conclusion would be that the respondents consistently over-reported their frequencies. However, if the obtained average were not significantly different, then either or both of the above two reasons could be valid. Note that using the lower bound as the representative value is a conservative test, as the true average for the category is almost certainly higher than the lower bound.

The average telecommuting frequency obtained from the attitudinal survey, using the lower bound rather than the midpoint of the interval as the frequency value for each category, is presented in the last row of Table 4-10. Using this approach, the average obtained from the attitudinal surveys is still greater than the averages obtained from the one-month and six-month sign-in log data. However, t-tests reveal that the differences between AS and SIL6 (t = 1.01; p-value = 0.328) and between AS and SIL1 (t = 0.56; p-value = 0.582) are not statistically significant. This implies that the higher average obtained from the attitudinal surveys could be the result of either an over-reporting bias on the part of the respondents in the attitudinal survey, or an artifact in the way point frequencies were estimated from the categorical (interval) responses.

This equivocal result calls for even deeper exploration. Since we have the sign-in log data representing actual telecommuting frequencies, we can reconstruct the true distribution of frequencies across the sample and compare that to the distribution based on the reported frequencies of the attitudinal survey. If the observed result is due to the fact that actual frequencies tend to fall in the lower half of the reported frequency category, the distributions from the two sources will match relatively closely at the category level. If, on the other hand, reported frequencies tend to overstate actual frequencies, then there will be a mismatch of the two distributions, with the reported frequency distribution disproportionately skewed toward higher frequency categories.

Figure 4-11 and Table 4-11 show the telecommuting frequency distribution from the attitudinal survey data, six-month sign-in log data, and the one-month sign-in log data. Visually, the figure indicates that although the AS distribution is relatively similar to the SIL1 distribution, it is skewed slightly upward. In particular, several more respondents reported an AS frequency of three or more days per week than actually telecommuted that often within the last month, which accounts for the higher average frequency obtained from the attitudinal survey. Nevertheless, a chi-squared test emphatically fails to reject the hypothesis that the two distributions are equivalent. However, the differences between AS and SIL6 are more pronounced (especially in the same three-or-more-days-per-week range), with a chi-squared test rejecting the equivalency hypothesis at a level of significance of 0.10 but not at 0.05.

Table 4-11: Comparison of Three Measures of Telecommuting Frequency (N=39)

Frequency	Attitudinal Survey (AS)	Six-month Sign-in Log (SIL6)	One-month Sign-in Log (SIL1)
< 1/month	8	11 (4,7)	11 (11,0)
1-3/month	10	14 (7,7)	11 (3,8)
1-2/week	11	12 (4,8)	11 (8,3)
3-4/week	9	2 (1,1)	6 (5,1)
5/week	1	0	0

SIL6-AS : χ^2 = **6.52** (critical χ^2 (3, 0.05) = 7.81)
SIL1-AS : χ^2 = **1.52** (critical χ^2 (3, 0.05) = 7.81)
(The χ^2 values were calculated after combining 5/week cells with 3-4/week cells.)

In the above table, the two numbers in the parentheses depict the number of respondents whose frequencies fell in the lower half and the upper half of the category, respectively. From the figures in the parentheses, we see that for SIL6 the frequency values do not predominantly lie in the lower half of the categories (16 lower, 23 upper), whereas for SIL1 they do (27 lower, 12 upper).

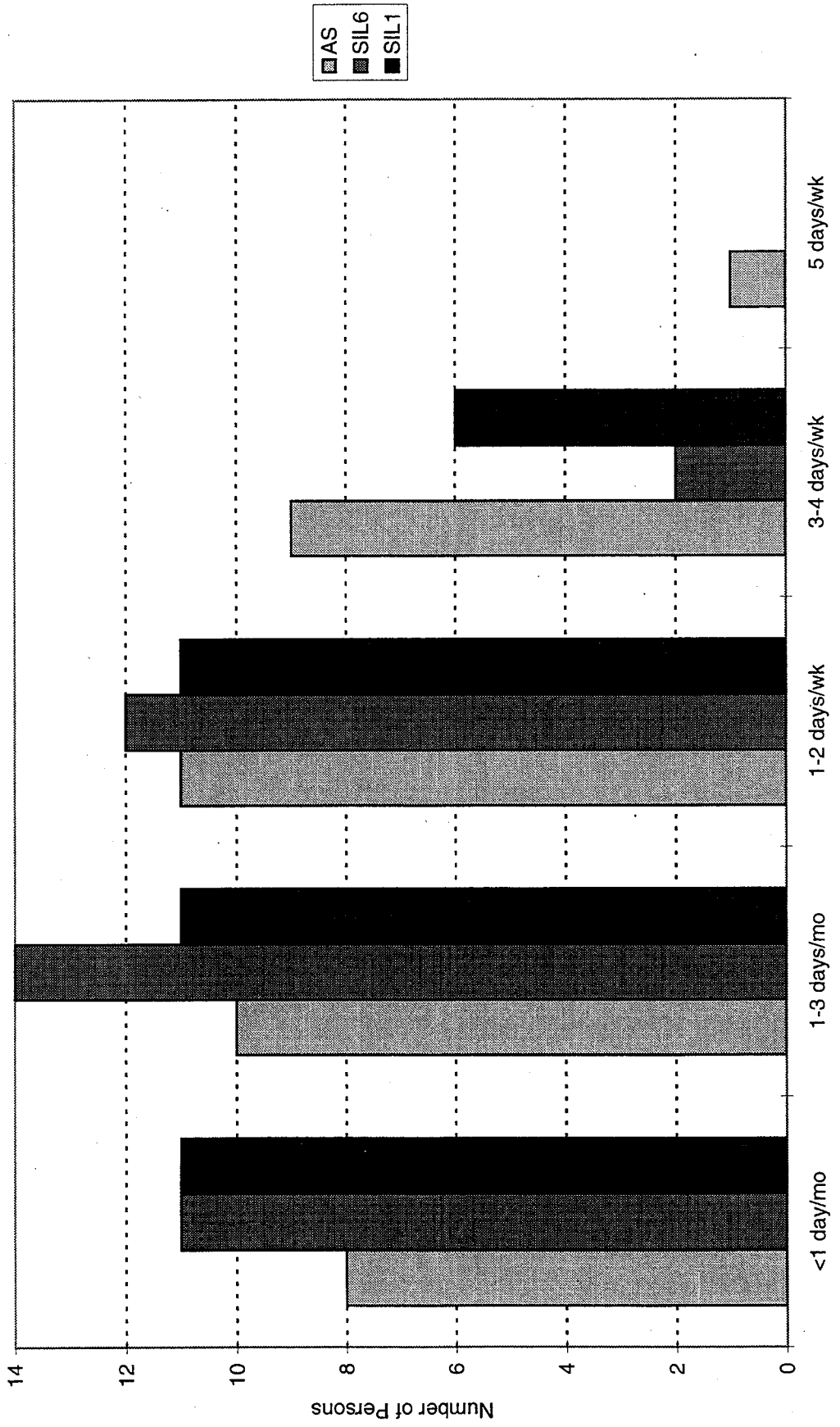


Figure 4-11: Telecommuting Frequency Distribution (N=39)

These results indicate that the telecommuting frequencies reported in the attitudinal survey do not differ significantly from the actual frequencies within the preceding month. There is a statistically weak, but suggestive, indication that the reported frequencies are higher than the actual frequencies over the preceding six months. The implication is that participants most heavily base their reported frequency on their most recent frequency (over the last month) rather than on their average frequency over a period of several months.

4.4.4 Proportion of Telecenter-only Working Days

In the aggregate analysis, it was found that the RABO telecommuters worked entirely at the telecenter for nearly 60% of the days on which telecommuting occurred. Individual telecommuting behavior is further analyzed below.

Figure 4-12 illustrates the distribution of the proportion of telecommuters that worked entirely at the telecenter on telecommuting days. The ratio is calculated by dividing the number of telecommuting-only days over the total number of telecommuting occasions for an individual. Among the 92 telecommuters at RABO sites, 21.8% worked entirely at the telecenter on all telecommuting days, and another 22.8% had a high proportion (80%-99%) of telecenter-only days. It was also found that seven telecommuters (7.6%) always worked at additional workplaces on all telecommuting days. Approximately 34% of the RABO telecommuters worked at more than one location on telecommuting days at least 60% of the time.

The distribution according to each site shown in Table 4-12 has some consistency with the patterns found in the aggregate analysis (shown in Table 4-5). For the sites with a large proportion of telecenter-only telecommuting occasions, such as at Modesto, 90% of the telecommuters worked only at the telecenter on their telecommuting days. For those sites with a small proportion of telecenter-only occasions, such as Ulatis, Alamo, and Chula Vista (H St.), about half of the telecommuters had telecenter-only occasions 40% of the time or less. The implication is that these individuals frequently worked at two or more workplaces on telecommuting days. For the sites with few telecommuters, such as Moorpark Community College and Ventura Community College, the distribution shown in Table 4-12 indicates that some site-specific patterns shown in Table 4-5 are heavily influenced by one or two individuals.

4.4.5 Individual Work Time Spent at the Telecenter

From the aggregate analysis, it was found that work time spent at the telecenter on telecommuting occasions varied because telecommuters worked at a number of different locations in the same day. In this section, an attempt is made to establish the pattern of individuals. The behavior at a disaggregate level may differ from the average results of the site-level analysis.

The average work time spent at telecenters by an individual was calculated by dividing the sum of work time for all his/her telecommuting occasions by the total number of those occasions (missing data was excluded). The distribution of the resulting average work time is presented in Figure 4-13. Nearly 53% of the telecommuters worked at the telecenters more than six hours per telecommuting occasion on average. The majority (71.7%) stayed at the telecenters for more than four hours. This shows that the telecenter was the main workplace for most of the telecommuters

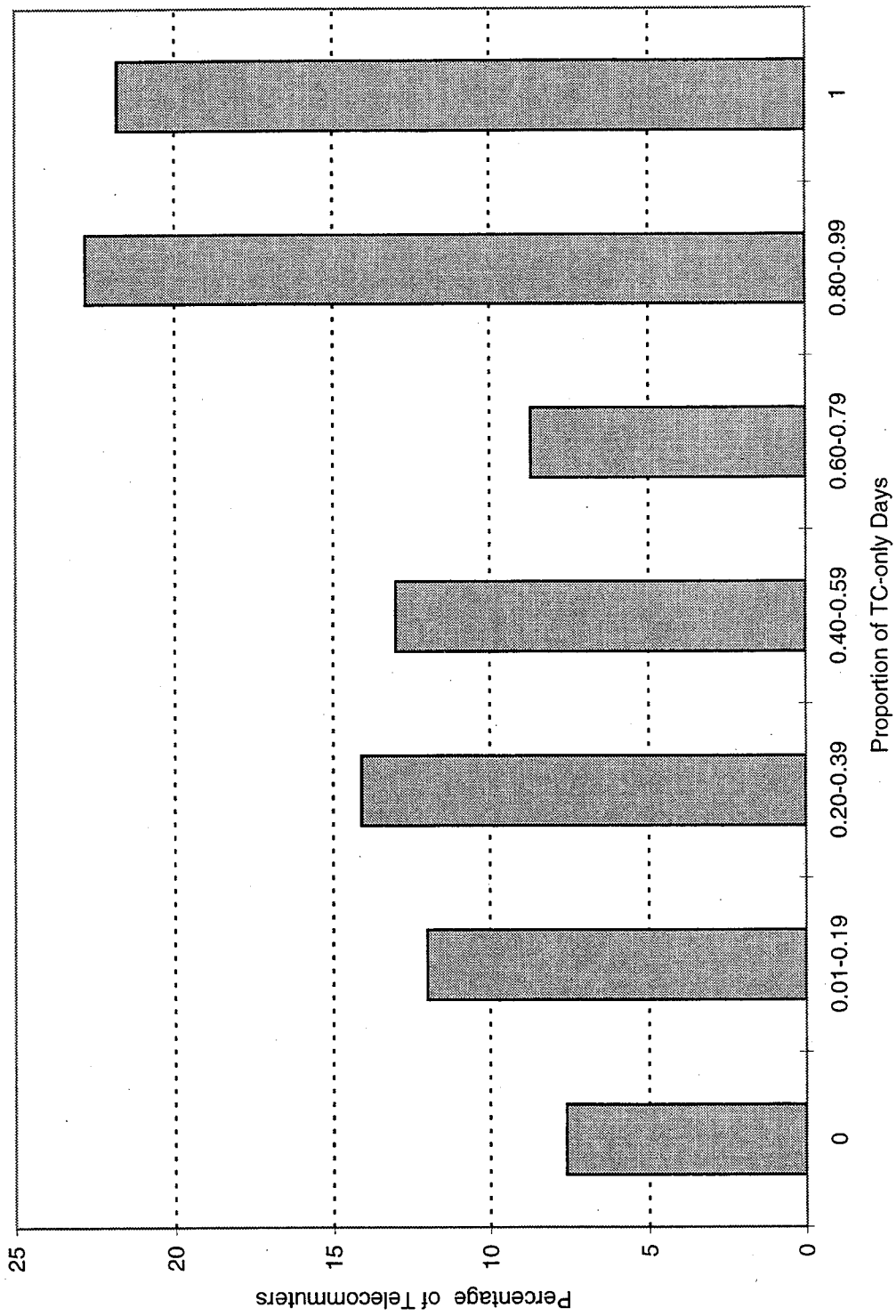


Figure 4-12: Proportion of Telecenter-only Working Days by RABO Telecommuters (N=92)

Table 4-12: Distribution of the Percentage of Telecenter-only Working Days by RABO Telecommuters

Site	N[1]	0%	1-20%	21-40%	41-60%	61-80%	81-99%	100%
Coronado	9	22.2%	22.2%	---	11.1%	11.1%	33.3%	---
Grass Valley	8	---	12.5%	---	---	---	50.0%	37.5%
Anaheim	10	---	10.0%	10.0%	20.0%	10.0%	40.0%	10.0%
Vacaville (2 Sites)	26	3.8%	11.4%	38.6%	15.4%	7.7%	15.4%	7.7%
Davis	3	---	---	---	33.3%	33.3%	---	33.3%
Chula Vista - H St.	12	16.7%	16.7%	16.7%	8.3%	---	25.0%	16.7%
Modesto	10	10.0%	---	---	---	---	---	90.0%
Chula Vista - F St.	5	20.0%	---	---	20.0%	20.0%	20.0%	20.0%
Ventura	3	---	33.3%	33.3%	---	---	---	33.3%
La Mesa	4	---	---	---	---	25.0%	50.0%	25.0%
Moorpark	2	---	---	---	100%	---	---	---
Total	92	7.6%	12.0%	14.1%	13.0%	8.7%	22.8%	21.8%

[1]N is the number of telecommuters.

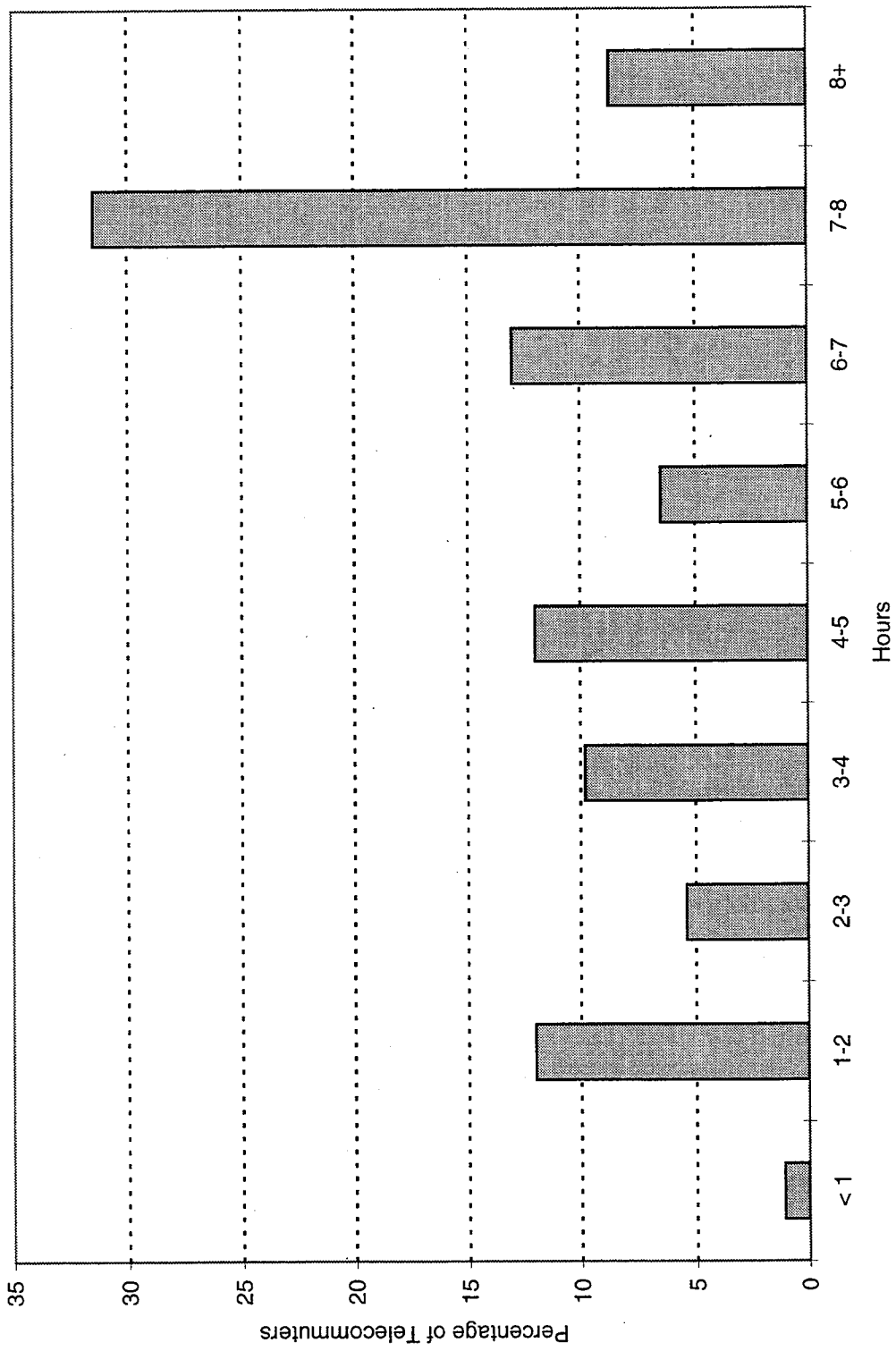


Figure 4-13: Distribution of Average Work Time at the Telecenter for RABO Telecommuters (N=92)

on telecommuting days even though they might have more than one work location. A substantial minority (more than a quarter of the sample), however, typically used the telecenter for half a day or less – either as a drop-in location between work-related meetings elsewhere or in conjunction with telecommuting from home or commuting to the conventional workplace.

Interestingly, a significant proportion of the RABO telecommuters (8.7%) were likely to work more than eight hours per day at the telecenter. On average, 41.2% worked at the telecenter for at least seven hours per telecommuting day. However, from the distribution shown in Figure 4-12, only 21.8% worked exclusively at the telecenter. If they all worked for at least seven hours, there still is a significant proportion of individuals (19.4%) who not only worked at the telecenter for at least seven hours on average but also spent some time at other workplaces.

4.4.6 Mode Choice to the Telecenter

The examination of the mode choice behavior of the telecommuters uses an approach similar to the previous analysis of individual patterns of workplace use. The frequency of driving alone on telecommuting days is calculated through dividing the number of telecommuting occasions on which a person drove alone by the total number of telecommuting occasions for that individual.

Figure 4-14 shows the corresponding distribution at RABO sites. About 46% of the telecommuters drove alone to the telecenter for all telecommuting occasions. More than two-thirds (71.2%) drove alone frequently (more than 75% of their occasions). About 54% used other modes, such as carpooling or being dropped off, to reach the telecenter at least occasionally. Only 4% of the telecommuters never drove alone to the center. The above findings confirm that driving alone was the prevailing transportation mode of choice despite the effort to locate the centers close enough to residential neighborhoods so that walking and biking would be attractive options.

4.5 Summary and Conclusions

This chapter describes a study of the telecommuting patterns of center-based telecommuters, taken primarily from information compiled from the attendance logs at the telecenters. This analysis identifies patterns of telecommuting duration and frequency, and increases our understanding of telecommuter working behavior on telecommuting days. The study analyzes telecommuting patterns both at the aggregate (site) level and the disaggregate (individual) level. Both analyses are consistent with each other and complementary.

For most of the telecenters, a usage rate of between 10% and 20% was maintained. Though the usage rates fluctuated, overall growth is apparent. As of the June 30, 1995 cutoff date for this interim report, the RABO telecenters had been open an average of 9.1 months, with a minimum of 2.5 months and a maximum of a little more than 20 months. The two non-RABO telecenters have been operating for much longer, an average of 3.1 years.

At RABO sites, the average telecommuting frequency was 25%, or 1¼ days per week. More than half of the telecommuters telecommuted less than one day per week on average, and 22% telecommuted 1 to 2 days per week. The non-RABO telecommuters telecommuted less frequently than those who were at RABO sites; the average was 17.2%, with about 75% of non-RABO telecenter users telecommuting less than one day per week.

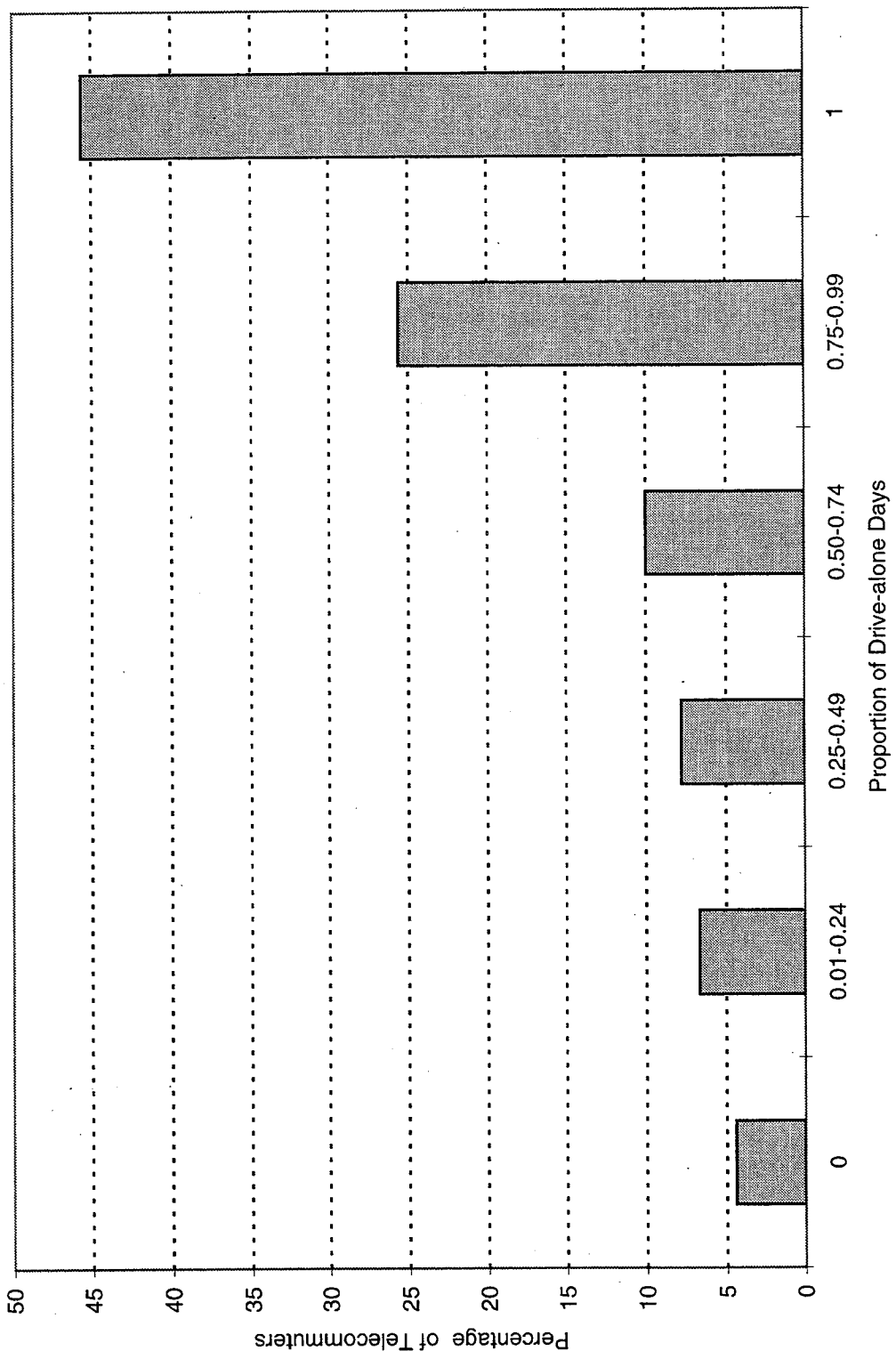


Figure 4-14: Proportion of Driving Alone to the Telecenter by RABO Telecommuters (N=90)

Attrition at the telecenters was relatively high, with 50% of all telecommuters quitting within the first nine months. Although little comparative data are available, this appears to be higher than for home-based programs. Reasons for quitting telecommuting are analyzed in Chapter 5. But in any case, the frequency and distribution of telecommuting are crucial factors to consider in any forecast of levels and impacts of telecommuting. Of the 92 RABO participants who telecommuted often enough to analyze, half telecommuted for at least 8 months, and more than 25% telecommuted for at least one year. At non-RABO sites, 50% of the 130 telecommuters analyzed telecommuted for at least 9 months, and 25% telecommuted for at least 2 years. There is no significant difference in telecommuting duration between RABO and non-RABO sites.

A majority of telecommuters (53%) worked at the telecenters for at least 6 hours on average on their telecommuting days. The most common telecommuting pattern was to work entirely at the telecenter. Approximately 22% of the telecommuters at RABO sites telecommuted with this pattern on all of their telecommuting occasions, and an additional 23% did so at least 80% of the time. At least 34% usually worked at more than one work location, including 8% who always did. The second most common workplace combination was telecenter/other work location (i.e., other than home or the regular workplace). Contrary to expectation, center- and home-based telecommuting are not often combined on the same day; patterns involving these two locations occurred only 17% of the time at RABO sites.

Driving alone was the dominant transportation mode used by the telecommuters in commuting to the center. About 46% of the RABO telecommuters drove alone to the center on all of their telecommuting occasions. More than two-thirds drove alone to the center very frequently (more than 75% of their occasions).

CHAPTER 5

ANALYSIS OF TELECOMMUTING RETENTION

5. ANALYSIS OF TELECOMMUTING RETENTION

5.1 Analysis and Classification of Stayers and Quitters

Many evaluation reports on telecommuting programs make little or no reference to attrition among telecommuters. Very few actually study attrition seriously (Quaid and Lagerberg (1992) is one exception), yet the importance of this factor to estimating the adoption and impacts of telecommuting cannot be emphasized enough. Forecasts of the proportion of the workforce likely to become telecommuters (and derivative forecasts, such as impacts on transportation) implicitly assume "once a telecommuter, always a telecommuter". But if the typical participant only telecommutes six months before terminating the arrangement (or, viewed another way, if only two percent of those who will ever telecommute are doing so at any given time), then impact assessments based on the proportion of the workforce ever expected to telecommute will be wildly overstated. In this chapter, we examine the attrition of telecenter users and explore the reasons for that attrition.

Telecommuting retention is analyzed in the following three ways. In Section 5.2, the attitudes and characteristics of those participants who remain in the program (stayers) are compared with those who left it (quitters). The goal is to determine which work and household variables may affect the decision to stop telecommuting from a center. In this study, work and household data was collected using an attitudinal survey as described in Section 3.2. A subset of the before-wave data is used to compare and contrast the stayers and quitters according to selected factors that are hypothesized to influence the decision to quit.

Another way to determine the causes of attrition is to examine the motivations to quit, as presented in Section 5.3. Some possible reasons for dropping out of a telecommuting program include residential relocation, changes in job duties, technical problems, and discomfort with telecommuting. Particularly important to this project, those who quit using a telecommuting center may, in fact, prefer telecommuting from home. The motivation for leaving the telecenter program was the most important part of the exit interview, which was conducted, where possible, with each telecenter user who left the project.

The comparison of stayers and quitters in terms of the duration and frequency of telecenter use, presented in Section 5.4, is still another way to analyze telecommuting retention. Individual telecommuting duration and frequency can be computed from the attendance log data as described in Section 4.4. A particular pattern of telecenter use may be characteristic of each group. These patterns may suggest a possible motivation for quitting or may be used as an indicator of the likelihood to quit. In addition, questions about the current and ideal distribution of work time were included in the exit interview. A difference between current and ideal work frequency can show whether a preference for telecommuting from a center still exists even though the respondent has ceased to telecommute from the center.

Before the aforesaid analyses can be conducted, an appropriate study group must be chosen. The identification of the sample of stayers and quitters begins with the group of respondents to the before employee survey. The before-wave data are used here since not all participants in the RABO Project (especially those who quit) completed after surveys. The attitudinal data will allow the comparison of attitudes and characteristics between the two groups of interest (see

Section 5.2). Of the 61 respondents in the before telecenter user data set, 15 respondents from the sites that ceased operation or withdrew from the RABO Project (Roseville, Anaheim, Concord, Citrus Heights, and Davis) were excluded from further consideration. For these cases, the reason for quitting is likely to be the closing of the center rather than employment requirements or personal preference. In addition, attendance log and exit interview data are scarce or non-existent from these sites (in the final report, telecommuting termination caused by site closing will be investigated further). The remaining 46 respondents were assigned stayer or quitter status according to information collected prior to June 30, 1995 from the attendance logs. The assignations were then cross-checked with current tracking of telecommuters to verify the respondents' project participation status. According to the classification process, 22 of the respondents are stayers and 24 are quitters.

5.2 Attitudes and Characteristics

Unlike the earlier description of telecommuter characteristics (see Section 3.2), the following comparison of the stayers and quitters only uses the data collected in the before surveys. Data from the early wave of surveys are used since the majority of the quitters ceased telecommuting prior to the administration of the later wave of surveys. Thus, information on attitudes and characteristics is only available from the before surveys. The comparison of the survey results for the 22 stayers and 24 quitters covers the sections of the survey in the following order: demographic and travel characteristics, job characteristics, amount of telecommuting, and job satisfaction and work environment characteristics.

The stayers and quitters are relatively similar according to demographic indicators. There are comparable distributions for gender, age, and educational background. Both groups are statistically similar in terms of household size and available vehicles (see Table 5-1). Quitter households have more part-time workers and generally have higher incomes; a total of twelve quitters are in the top two income categories compared to only six stayers. While the stayers and quitters had similarly long commutes to the regular workplace (about 41 miles, on average), quitters had to travel 3.5 miles farther, on average, to the telecenter.

Table 5-1: Demographic and Travel Characteristics for Stayers and Quitters

Question	Mean[1]		t-statistic	p-value
	Stayers (N=22)	Quitters (N=24)		
Household size	2.91	2.71	-0.54	0.594
Full-time workers	1.45	1.21	-1.14	0.259
Part-time workers	**0.18**	**0.54**	**2.22**	**0.031**
Vehicles per household	2.18	1.96	-1.07	0.293
Miles to regular workplace (one-way)	41.40[2]	41.69	0.04	0.969
Miles to telecenter (one-way)	4.11[2]	7.72	1.50	0.140

[1] Bolded means are significant at $\alpha \leq 0.10$.

[2] N = 21

Job characteristics also did not vary much between stayers and quitters. Similar numbers of the two groups had manager/administrator and professional/technical positions, but five of the seven administrative and only one of the six sales workers were quitters. Perhaps administrative support duties were less amenable to telecommuting from a center than sales tasks since the latter usually involves site visits while the former requires office equipment and files. Quitters had generally longer experience (about two more years with the firm and in the occupation) which suggests a possible difficulty in adapting to a new work arrangement (see Table 5-2). This hypothesis is supported by the fact that more quitters (9) had conventional eight-hour schedules than stayers (4) and more stayers (13) had flextime schedules than quitters (5). However, both groups had worked for their respective supervisors about the same length of time on average, and none of the differences in the experience variables were statistically significant. Surprisingly, quitters spent significantly more time working independently and remotely (tasks well-suited for telecommuting) than stayers and, consequently, spent less time working face-to-face or at a specific location (see Table 5-2). Stayers had significantly more work-related travel, probably because more of this group were sales people.

Table 5-2: Work Characteristics for Stayers and Quitters

Question	Mean[1]		t-statistic	p-value
	Stayers (N=22)	Quitters (N=24)		
Years worked for supervisor	2.58[2]	2.85[3]	0.27	0.792
Years worked for employer	6.72	8.56[3]	0.83	0.412
Years worked in occupation	8.06[2]	10.15[4]	0.91	0.367
Independent and remote time	**58.27%**	**71.13%**	**1.91**	**0.062**
Face-to-face and location time	28.36%	22.69%	-1.16	0.253
Work-related travel time	**12.91%**	**6.19%**	**-1.85**	**0.071**

[1] Bolded means are significant at $\alpha \leq 0.10$.
[2] N = 20 [3] N = 21 [4] N = 22

The two groups also had comparable experience with telecommuting. While a similar proportion of each group (about one-quarter) had prior experience with telecommuting (most likely the home-based form), the quitters have had the longer average duration of past telecommuting experience (see Table 5-3). However, this difference is not statistically significant and is based on a small sample (seven stayers and six quitters).

The average ideal distributions of time among the possible work locations were relatively similar (see Table 5-3); however, the quitters did assign a slightly larger percentage to the regular workplace and a slightly smaller percentage to the telecommuting center. Quitters and stayers have similar average center-based telecommuting frequencies for job suitability, manager support, preference, and expectation (see Table D-1, Appendix D). However, there are larger differences for home-based telecommuting for the same categories, with quitters favoring this option more

than stayers. In fact, quitters preferred to telecommute from home for 24% of the time compared to only 12% for stayers. However, quitters preferred to telecommute from a center more than twice as frequently as from home (50% of the time). So, for some of the quitters, their experience with and preference for home-based telecommuting may have led them to choose to telecommute from home rather than from a center.

Table 5-3: Telecommuting Experience and Preference for Stayers and Quitters

Question	Mean[1]		t-statistic	p-value
	Stayers (N=22)	Quitters (N=24)		
Years of telecommute experience	1.60[2]	5.00[3]	1.18	0.263
Ideal % at the regular workplace	41.32%	47.97%	0.91	0.367
Ideal % at the telecenter	42.05%	36.82%	-0.70	0.489
Ideal % at home	10.05%	11.25%	0.23	0.816
Preferred % from a center	55.90%	50.21%	-0.64	0.525
Preferred % from home	**12.16%**[4]	**23.54%**[5]	**1.72**	**0.094**

[1] Bolded means are significant at $\alpha \leq 0.10$.
[2] N = 7 [3] N = 6 [4] N = 21 [5] N = 19

There were few meaningful differences between stayers and quitters in attitudes about work and the workplace. In fact, none of the average responses to job performance and satisfaction questions had significant differences (see Table D-2, Appendix D). A few of the work environment characteristics were different, however (see Table D-3, Appendix D). Stayers expected distractions at the telecommuting center to be less of a problem than quitters ($p = 0.012$), so perhaps the quitters are likely to be more sensitive to distractions than the stayers. In addition, quitters were less worried about over-indulging at the regular workplace ($p = 0.038$) or at the center ($p = 0.011$) and felt they had fewer opportunities for professional interaction at the regular workplace ($p = 0.047$). T-tests on the mean importance rating of the work characteristics showed only two significant differences between the groups (see Table D-4, Appendix D). Quitters rated having equipment and services and dressing comfortably more important than stayers did ($p = 0.031$ and 0.050, respectively). The need for equipment may show a preference for returning to the regular workplace, but the desire to work comfortably likely reflects a desire for working at home where formal business attire is not necessary.

Although the results of the attitudinal survey serve to characterize the stayers and quitters, they do not give much insight into why some participants chose to quit. Even the statistically significant results reported above do not provide compelling reasons for wanting to stop telecommuting. In fact, the quitters do not view the telecenter negatively for any characteristic which might be expected of those who want to quit (such as feeling motivated at work, distractions from others, having necessary equipment, etc.). However, these surveys were administered prior to the start of telecenter use, so attitudes about working from the

telecommuting center may have changed over time. As a result, there is little basis for predicting who will quit telecommuting from the center using the data collected with the before wave of attitudinal surveys.

5.3 Reason for Quitting

For the 24 participants who were identified as quitters (see Section 5.1), an attempt was made to conduct an exit interview with each one, primarily in order to identify the reason for quitting. However, contacting and eliciting information from all quitters proved to be difficult since they may no longer have felt an obligation to participate or may have changed phone numbers. Despite this, at least some data (some of it second-hand) is available for all but four of the quitters.

The reason(s) given for leaving the telecenter program are shown in Table 5-4 (the frequencies do not sum to 24 because one respondent gave more than one reason for quitting). The most frequently given explanation (25% of the quitters) was that they changed positions within the company or the tasks assigned to their position changed. This was mostly the result of corporate downsizing which required employees to take over some tasks that formerly belonged to other positions. Thus, they needed to be at the main office more or in some other way could not complete their new tasks at the telecommuting center. Similarly, on a previous study of home-based telecommuting retention, office problems and job changes accounted for 29% of the reasons for dropping out of the program (Quaid and Lagerberg, 1992).

Table 5-4: Reasons for Quitting

Reason	Number (Proportion)
Changed jobs within the organization	6 (25.0%)
Left company	3 (12.5%)
Employer/supervisor required that the worker quit	2 (8.3%)
Changed supervisors	2 (8.3%)
Moved	2 (8.3%)
Employer/supervisor encouraged the worker to quit	1 (4.2%)
Technological problems	1 (4.2%)
Wanted to switch to more home-based telecommuting	1 (4.2%)
Other	3 (12.5%)
Unknown	4 (16.7%)

The next most important reasons relate specifically to the supervisor and/or employer. Supervisors' and/or employers' attitudes led five of the participants to quit (21%). Of these five employees, two employees were required to quit by their current employer and/or supervisor, two had new supervisors which required the change, and one was encouraged to quit by the employer and/or supervisor. Other reasons for quitting were leaving the company for a new job (12.5%) and residential relocation (8.3%). For four of the 24 quitters (16.7%), the reason for leaving the program is unknown. It appears that these telecenter users were generally forced to quit because of outside circumstances (change in job duties or supervisor decision). This contrasts with the previous retention study where lack of equipment (17%) and personal dissatisfaction with telecommuting (8%) were important reasons for quitting (Quaid and Lagerberg, 1992).

The exit interview also contained a pair of questions about the prospects for future telecommuting by the respondent. Of the nine quitters (37.5%) who completed this part of the interview, only one respondent categorically refused to consider telecommuting from a center again, while two would not consider telecommuting from home. For this subgroup of the quitters, their preference is to continue to use telecommuting centers. The preference for more telecenter use in the future, as well as the reasons given for quitting, suggest that external constraints often prevent the adoption and the continuation of telecommuting programs.

5.4 Telecommuting Duration and Frequency

The attendance logs are the primary data source for telecommuting duration and frequency (see Sections 4.4.1 and 4.4.2 for duration and frequency for the overall sample of project participants). Although both the attitudinal survey and the exit interview ask these questions about telecenter use, these responses are considered to be only rough estimates. While there are undoubtedly a few missing telecommuting occasions in the attendance logs, they likely provide the best measurement of both duration and frequency. Importantly, some of the quitters had zero duration and frequency: these four (16.7%) did not use the center at all. In addition, four more quitters used the center only once, and hence both duration and frequency measures will be zero for them. As a result, statistics for both the total set and the "non-zero" set of quitters are reported below.

The average duration of telecommuting can be used to estimate how long telecommuters will stay in the program before dropping out. For stayers, this measure is not final since they are still telecommuting. However, for comparison purposes the current duration of telecommuting for stayers is 10.7 months, on average, as of June 30, 1995. From the attendance log data, the average duration for all quitters is 5.1 months (assuming 30-day months). For those quitters who telecommuted at least two occasions, the average duration was about 2 months longer, 7.2 months (see Table 5-5). The median duration for both groups is shorter (4.3 and 6.5 months, respectively), which suggests that the majority of the quitters leave the telecommuting program in less than 7 months. The distribution of telecommuting duration by the quitters, shown in Figure 5-1, has a peak between 5 and 8 months and a long tail.

Unlike telecommuting duration, the frequency of telecommuting occasions for both stayers and quitters can be compared (see Table 5-6). The average frequency of telecommuting among stayers is 29.6%, or about 1½ days per week. For all quitters, the average frequency is 16.0%,

but the average of those who telecommuted more than once is 24.0% (1¼ days per week). Although the stayers telecommute more frequently on average, the difference between the two groups is small. As above for duration, the median is less than the mean for telecommuting frequency for all three groups. The distribution of telecommuting frequency is shown in Figure 5-2. Over half of the non-zero quitters (9 out of 16) telecommuted one to three days per month, while only a little less than one-third (7 of 22) of the stayers telecommuted this amount. In contrast, the majority of the stayers (13 of 22) telecommuted more than one day per week, while less than half of the quitters telecommuted this much (7 of 16). Although the differences in frequency are not that great, it appears that the high-frequency telecommuters are more likely to continue using the telecenters. This is not to say that higher frequency of telecommuting is a cause of longer retention; rather, it is likely that a stronger motivation to telecommute (for some undetermined reasons) is the cause of both outcomes.

Table 5-5: Telecommuting Duration (Months)

Group	N	Mean	Median	Std. Dev.
Stayers (as of 6/95)	22	10.7	9.4	4.7
Quitters (all)	24	5.1	4.3	5.7
Quitters (non-zero)	16	7.2	6.5	5.5

Table 5-6: Telecommuting Frequency of Stayers and Quitters

Group	N	Mean	Median	Std. Dev.
Stayers	22	29.6%	25.5%	21.6
Quitters (all)	24	16.0%	13.4%	17.7
Quitters (non-zero)	16	24.0%	18.8%	16.6

As mentioned earlier, questions concerning telecommuting duration and frequency were included in the exit interview. On average, the quitters reported using the telecenter for 7.4 months (standard deviation = 8.5, N = 18) although there is a wide range of responses (from none to three years). The average telecommuting frequency given by this group was about six days per month, or 27% (std. dev. = 4.8, N = 19). Only 3 (15.8%) of the quitters said they telecommuted from the center for more than two days per week. Although there is missing data from the exit interviews, the self-reported telecommuting duration and frequency are much higher than the averages calculated according to the attendance log data. This difference is either caused by misperception on the part of the participants, missing data in the attendance log, or for frequency, variation in the pattern of telecenter use.

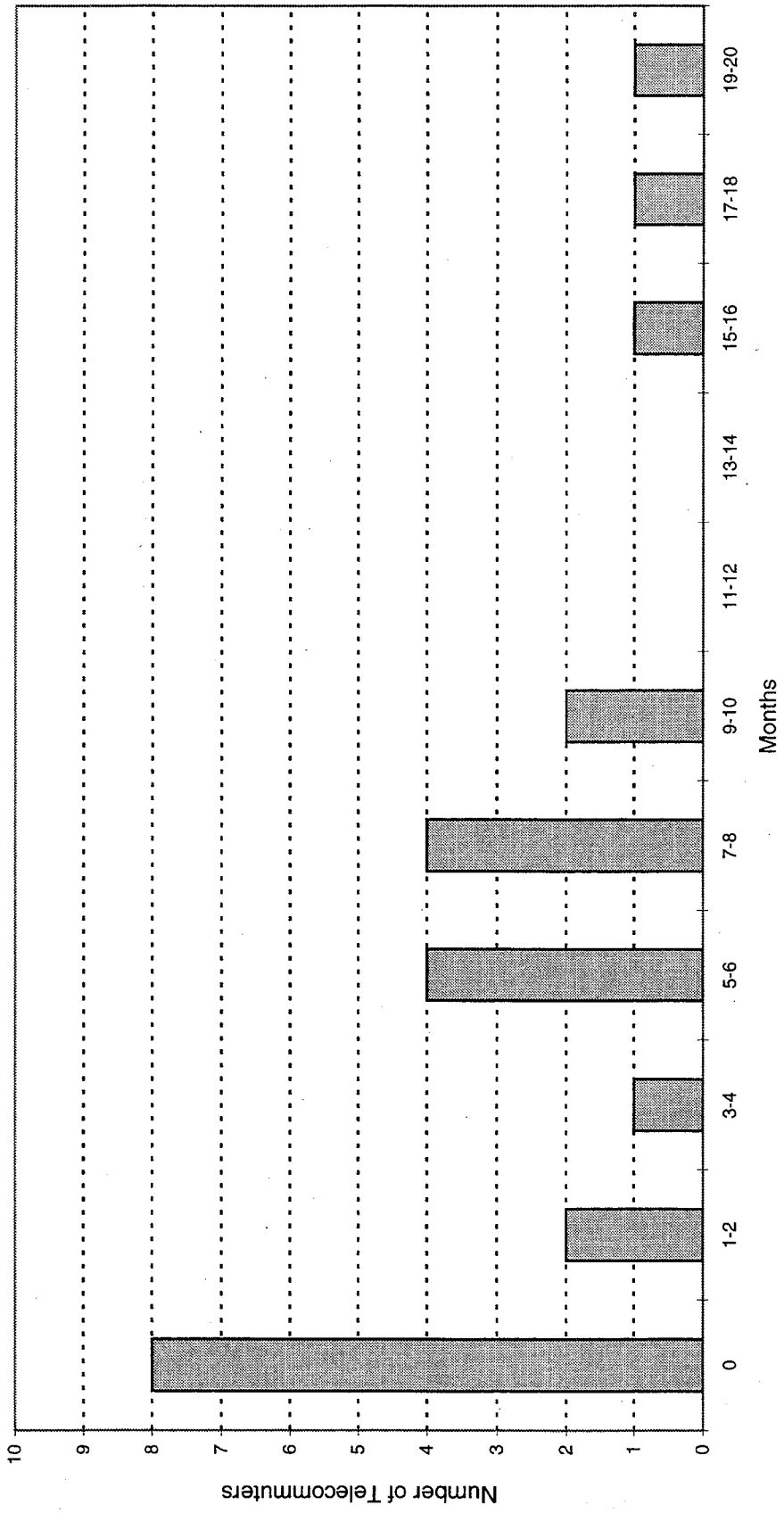


Figure 5-1: Duration Distribution of Quitters

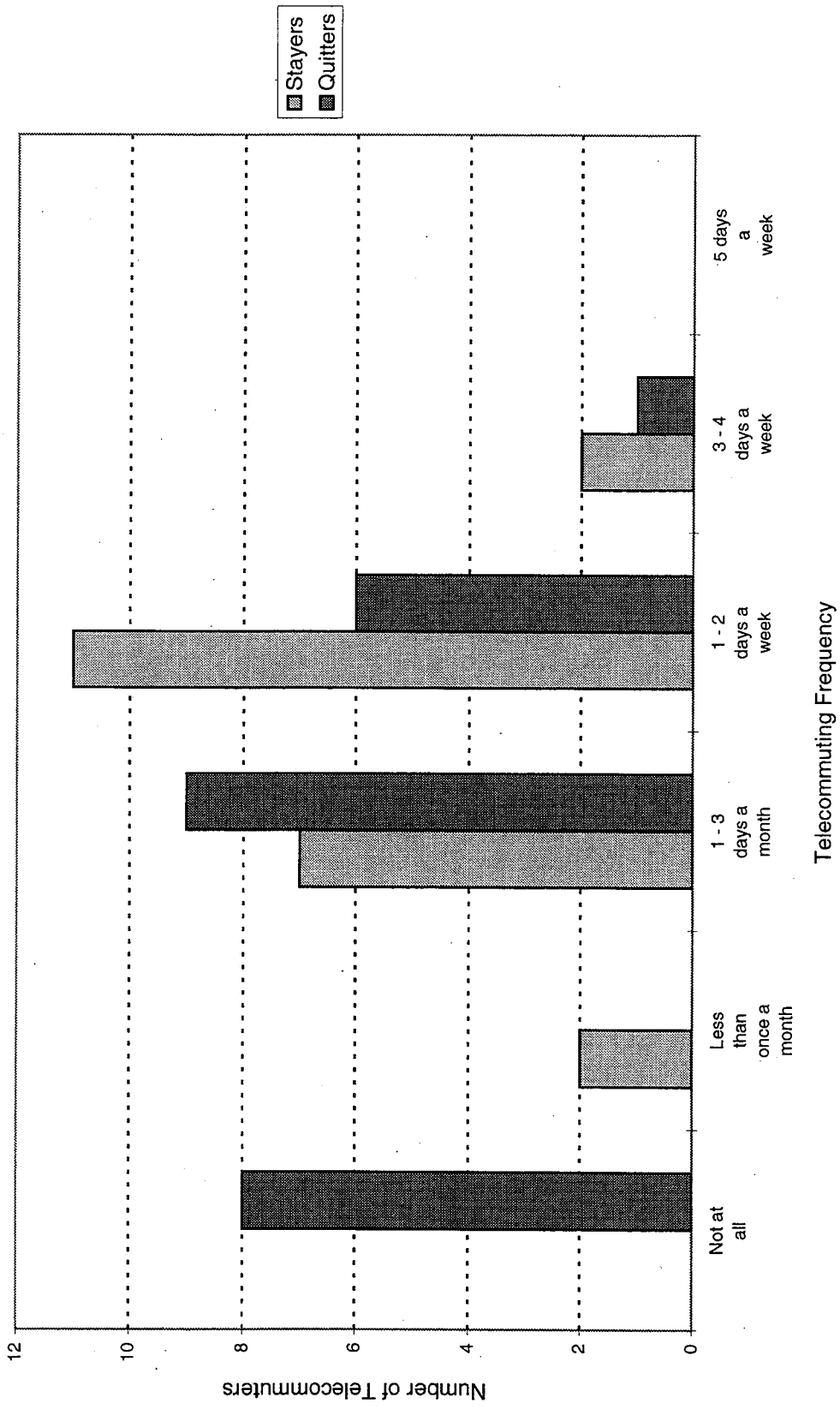


Figure 5-2: Frequency Distribution of Stayers and Quitters

Only nine respondents (37.5%) provided responses to the last part of the exit interview, regarding the ideal distribution of work time. At the time of the interview, these quitters worked primarily at the regular workplace (for 82.2% of their time) or at another location (13.3%, on average). Only one respondent telecommuted from home and none were utilizing another telecenter. However, according to the respondents, the average ideal distribution of their work time at the regular workplace, the telecommuting center, and home would be 50.9%, 38.7%, and 8.1%, respectively. So, many of the workers still preferred to use the telecenter but were not able to due to certain circumstances.

5.5 Summary of Retention Analysis

This chapter explored the attrition of telecommuters in the RABO Project. First, the characteristics of the respondents who quit were compared with the characteristics of those who stayed with the program. Second, the motivations of the quitters to leave the program were described. Third, the duration and frequency of telecommuting among both the stayers and quitters was investigated. In order to conduct this analysis, a particular sample of project participants was identified.

The responses to the before-wave surveys were used to find differences between 22 stayers and 24 quitters. According to employment type, administrative workers were more likely to quit (5 of the 7) and sales workers were more likely to remain in the program (5 of the 6). Surprisingly, quitters spent more time working remotely (more suited for telecommuting) than stayers. However, this result may explain why quitters preferred to spend more time working from home (23.5%) than stayers did (12.2%). Although job performance and satisfaction did not differ significantly between the two groups, certain work environment characteristics were significantly different. Quitters were more likely to worry about distractions at the telecenter and to consider the need for essential equipment to be important. Unfortunately, the findings from the survey data cannot point to the motivation for quitting, especially since the survey was administered prior to the experience with telecenter use.

The exit interview captured the reasons for quitting. The most important reason given was that respondents changed position within the company or their assigned tasks changed (25%). Thus, external corporate downsizing and reorganization were the most likely causes of quitting. Other important reasons include the supervisor requiring or encouraging the respondent to quit (21%) and leaving the company (13%). The reason for quitting is unknown for four individuals (17%).

The attendance log data showed that telecommuting duration and frequency varied widely within each group. The quitters who actually used the telecenter at least twice (16 of the 24 quitters) telecommuted an average of 7.2 months before leaving the program. For comparison, the stayers had telecommuted for an average of 10.7 months at the time of the final data entry. Quitters with some telecenter experience generally telecommute less often than stayers (24% vs. 30%, or 1¼ vs. 1½ days per week). This difference is reflected in the distribution of telecommuting frequency, where 9 quitters (56%) telecommuted less than one day per week while 13 stayers (54%) telecommuted one day per week or more. Perhaps quitters did not telecommute often enough to make the changes to their work schedule worthwhile.

CHAPTER 6

TRAVEL CHARACTERISTICS

6. TRAVEL CHARACTERISTICS

6.1 Motivation and Methodology

In recent years, telecommuting has generated considerable interest in the research and planning community for its potential as an effective transportation demand management strategy (Mokhtarian, 1991). As the adoption of telecommuting becomes widespread, opportunities arise to evaluate telecommuting for its ability to alleviate congestion and improve air quality (Koenig, *et al.*, 1996; Henderson, *et al.*, 1996). The travel and emissions impacts related to travel associated with telecommuting centers are of particular interest and have been little-studied to date.

Center-based and home-based telecommuting are likely to differ considerably in terms of the resulting transportation and air quality impacts. An obvious difference concerns the reduction in the regular commute. While telecommuting from a center may reduce the length of the regular commute, home-based telecommuting may eliminate it altogether. However, there may be an increase in the number of discretionary trips made on home-based telecommuting days since there is more time for discretionary activities. Also, it is possible that a home-based telecommuter engages in several short home-other-home trips involving minimal trip chaining. Thus, we are likely to see some interesting tradeoffs between distance and the number of trips, both of which are important factors in modeling air quality impacts.

This chapter examines the travel characteristics of the sample of telecenter users investigated in this interim report. Four fundamental travel indicators – number of trips, person-miles traveled (PMT), vehicle-miles traveled (VMT, here taken to be miles traveled by driving alone in a personal vehicle), and commute mode choice – were studied. These indicators offer an overview of key travel characteristics and the analysis of vehicle-trips and -miles in particular lays the groundwork for conducting a future emissions and air quality analysis on these data. The ideal analysis would be a three-way study involving *wave* (before and after), *group* (telecommuters and non-telecommuters) and *day* type (telecommuting and non-telecommuting) as illustrated in Figure 6-1. Unfortunately, the restricted sample size precludes the possibility of such an analysis. A before-and-after study on the interim data set would have greatly reduced the sample size as only respondents common to both the before and after waves could be considered. Instead, we compared the four measures listed above between *telecommuting (TC)* and *non-telecommuting (NTC) days* in the after wave for *telecenter users*, with the non-telecommuting respondents treated as a control group. The main advantage offered by this methodology is that of using a larger sample size. The disadvantage, however, is that observed differences between telecommuting and non-telecommuting may be confounded by spill-over effects from one group into another (for example, in the form of deferred trips). These interactive effects would be controlled for in a before-and-after study.

The data used in the following analyses come from three sources: the after travel diary, the after attitudinal survey, and the sign-in log (all of which are described in Section 1.2). The travel diary provided data for the analysis of the first three parameters: number of trips, PMT, and VMT. On the other hand, the calculation of the commute mode choice distributions was relatively complex and involved input from multiple survey elements. The procedures involved

will be discussed in detail in the appropriate sections. Before the analysis was carried out, the data set was cleaned and missing values were imputed where possible. On the after travel diary data, for example, the proportion of missing data ranged from none on most questions to nearly 8% for odometer readings. The proportion of missing data that could be corrected for the various questions ranged from none on the question regarding number of occupants to nearly 30% for the question on trip start times. These missing values were imputed by cross checking against other responses by the same respondent in the travel diary (for example, missing start times could be approximated from end times and an assumed average speed). Trip sequences were checked, and missing links were filled in to the extent possible. A total of 7 missing trips were added in order to complete trip records, one duplicated trip was deleted, and 18 trips with data entry errors were re-keyed.

6.2 Number of Trips, PMT, and VMT

In the following sections, the methodology used to study the first three travel indicators – number of trips, PMT, and VMT – is discussed, and the results of the analyses are presented. In Section 6.3, the methodology and the results associated with the study of mode choice distributions are presented.

6.2.1 Description of Travel Diary Data

The after travel diary data consists of *42 respondents* providing information for *127 person-days* (one person had four entries, all others were three-day diaries) and *586 total trips* (includes trips made on not working days). The respondents fall into one of the three study groups depending on their telecommuting status: telecenter users, home-based telecommuters, and non-telecommuters.

The travel diary contained the following question for each day: "*Today I am working from (check all that apply): primary office, telecenter, home, other location, not working*" (see Appendix H). Based on the response to that question, each person-day was classified as one of four possible types as shown in Figure 6-2. A *telecenter day* (TC) was defined as a day on which a person *worked from a telecenter* irrespective of any other accompanying work location; this is illustrated in the figure by having any point in the dark gray circle classified as TC, even if the point also lies in the intersection with either of the other two circles. A day was classified as *home-based telecommuting* (HB) when the person worked *only from home;* thus in the figure, only points lying in the exclusive portion of the circle are classified as HB. A day was considered to be *non-telecommuting* (NTC) if a person worked from a regular work location and did not use the telecenter, even if s/he worked from home as well. And finally, a day was classified as a *not working day* (NW) if on that day the person did not work at all.

The elements of Figure 6-2 have been shaded to represent a hierarchy of expected direct travel benefits. Days on which no trips are made obviously represent the ideal travel reduction and are colored white. Next in order are NW and HB days. Both types of person-days are expected to provide similar travel improvements as the commute trip is eliminated. Between these two types,

Figure 6-1: Three-way Analysis Involving Three Dimensions

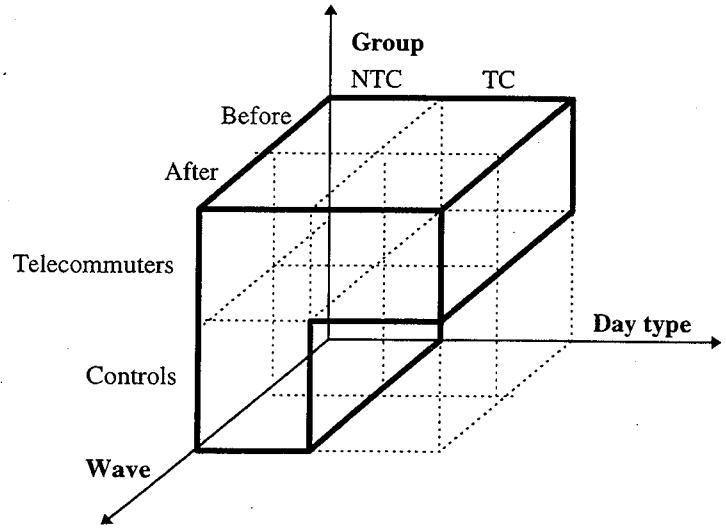
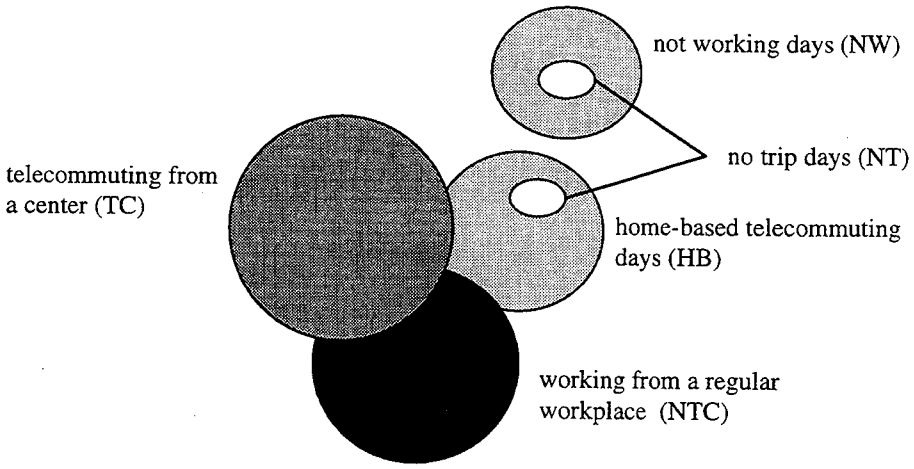


Figure 6-2: Classification of Person-days by Expected Direct Travel Impacts



however, HB days are expected to result in greater travel reductions than NW days since presumably on an HB day a large proportion of the participant's waking hours are spent working. The next best person-day type would be the TC day, as the commute trip is considerably shortened. And finally, representing the highest-travel scenario is the regular NTC day, shaded black. It should be noted however, that the proposed hierarchy does not take into account indirect travel effects, such as deferred trips or a compensating effect leading to an increase in discretionary trips, that may alter the hypothetical ordering.

Some features of this classification are worth noting: there are days when persons worked from more than one work location, but the maximum number of such locations is two (on no day in this data set did a person work from all three work locations). Person-days classified as TC include not only days on which telecenter was the only work location but also days on which either home or the regular workplace was involved. This was done because in assessing the travel impacts of telecenters, it is important to take into account the extent to which telecenter use is accompanied by working from other locations. Classifying TC-HB days as TC is reasonable because the person has to make a commute trip to the center irrespective of the amount of time spent there. By classifying TC-NTC days as TC, we are conservatively estimating the actual effect of telecommuting centers on travel, but thereby guarding against the careless assumption that *any telecenter occasion will automatically replace the normal commute.* On the other hand, we classify as NTC days, those days on which both home and the regular workplace were work locations because a person makes a commute trip to the regular workplace irrespective of the amount of time spent there.

One alternative to the scheme adopted would be to define separate categories for each combination of work locations: TC, TC-NTC, TC-HB, HB, HB-NTC, NTC. This would however, make the comparison process rather cumbersome and considerably reduce the number of cases available in each group. In Figure 6-3, the row and column titles – RW, TC, and HM – on the work location matrices refer to the regular workplace, the telecenter, and the home respectively. The group of non-telecommuters do not have a work location matrix as they have only one work location, namely, the regular workplace. As is evident from the figure, the alternative classification scheme would lead to very small classes. Referring to the work location matrix for telecenter users, for example, there is only one person-day on which both a center and a regular workplace was used and only one on which the respondent worked from home and used the center.

From a travel perspective, a day on which a person does not work at all is quite different from a work day (whether working from a regular workplace, telecenter, or home.) There is no commute trip and if the person is not working because he or she is indisposed there may be no discretionary trips either. On the other hand, the person might have taken the day off specifically to engage in discretionary activities. To illustrate these differences, Table 6-1a compares the number of trips, PMT, and VMT measures for the three day types under consideration.

Figure 6-3: Number of Person-days Distributed by Group and Work Locations

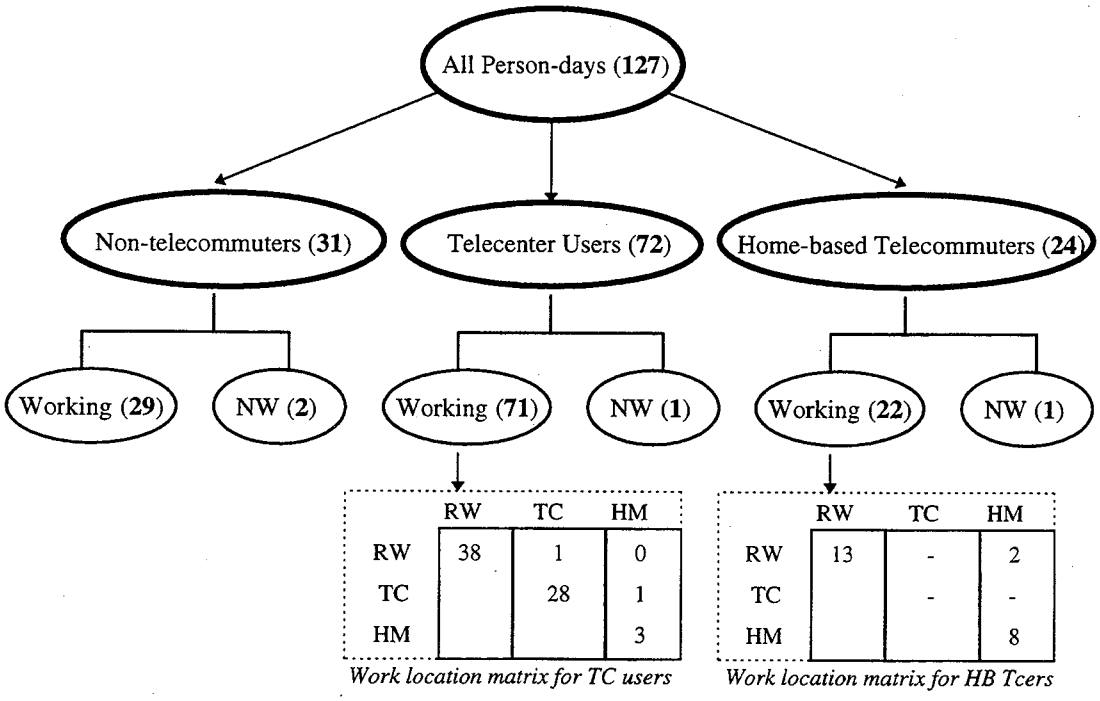


Table 6-1a: Number of Trips, PMT, and VMT by Day Type

	Avg. Number of Trips			PMT		
	TC	NTC	NW	TC	NTC	NW
Mean[1]	4.20	5.16	1.67	23.20	69.67	37.30
N	30	83	3	30	83	3
	Avg. Number of PV[2] Trips			VMT[2]		
	TC	NTC	NW	TC	NTC	NW
Mean[1]	4.20	5.11	1.67	20.75	43.91	35.47
N	30	83	3	30	83	3

[1] Mean calculated on a person-day basis.

[2] In the calculation of PV trips and VMT (vehicle miles traveled) only those trips which were made using a personal vehicle were considered.

Table 6-1b: Number of Trips, PMT, and VMT for NW Days and NTC Days Combined

	Average Number of Trips	PMT	Average Number of PV Trips	VMT
Mean	5.04	68.54	4.99	43.62
N	86	86	86	86

As can be seen from Table 6-1a, NW person-days are different from NTC days in terms of the average number of trips, PMT, and VMT. However, it could be anticipated that for this particular data set, pooling NW and NTC days would not affect the values of the travel parameters significantly. In fact, this has been the convention in previous studies. Table 6-1b presents the values for such a pooled group. By comparing the values from Tables 6-1a and b, we observe that the combined group has travel indicators that are slightly closer to those of the TC group than those of the NTC group alone. Thus, since combining the two groups provides more conservative estimates of the travel impacts of telecommuting, and for consistency with previous studies, we consolidate the NTC and NW groups in the analysis below. Should future studies involve a significant number of NW days, however, this day type should be analyzed separately in view of its distinctive characteristics.

For the remainder of this chapter, the NTC day type will include not working days. A final cross tabulation of the data set is given below in Table 6-2. As has been noted before, only the shaded cells, namely NTC and TC respondents on NTC and TC days, will be analyzed for the purposes of this report.

Table 6-2: Cross Tabulation of Person-days According to Study Group and Day Type

Study Group	Type of Person-day			Total
	NTC & NW	TC	HB	
Non-TCers	31	0	0	31
Center-based	39	30	3	72
Home-based	16	0	8	24
Total	86	30	11	127

In the section that follows, we first study the differences between the control and study groups for the three travel indicators – number of trips, PMT, and VMT. Following that, in Section 6.2.3 we compare telecommuting and non-telecommuting days for telecenter users. In Section 6.2.4 we analyze the distributions of trips across time of day and purpose. In the following section we examine commute and non-commute trips separately. Finally, in Section 6.2.6 we estimate the average workday travel impacts for telecenter users by taking into account the frequency of telecommuting.

6.2.2 Control Group vs. Telecenter Users

If the impact of telecommuting on travel is to be correctly understood, the effects of confounding factors need to be accounted for. In other words we need to eliminate or control for characteristics which are extraneous to the process of telecommuting but which may affect the final outcome. To do this, the travel characteristics of telecenter users on NTC days were compared with the control group of non-telecommuters. Statistical tests were conducted to study if the differences in the measures were statistically significant. The mean and standard deviation of each of the three travel indicators for the two groups under study, namely non-telecommuters (control group) and telecommuters on non-telecommuting days, are given below in Table 6-3.

Table 6-3: Comparison of Number of Trips, VMT, and PMT on Non-telecommuting Days

Study Group	Person-days	Indicator Mean (Standard Deviation)	
		Trips per Person-day	PMT per Person-day
Non-TCers	31	5.90 (3.77)	47.86 (34.09)
Center-based	39	4.31 (2.55)	90.87 (44.06)
	Pers. Vehicle (PV) days	PV trips per Person-day	VMT per Person-day
Non-TCers	31	1.84 (1.72)	31.85 (32.29)
Center-based	39	2.26 (1.29)	58.91 (51.35)

The average number of trips per person-day made by each group was found to be *significantly different* ($p = 0.052$), with the non-TC group making significantly more trips than the center-based telecommuters. On the other hand, the differences were *insignificant* ($p = 0.265$) if only personal-vehicle trips were considered, as is shown in the lower half of the table. The PMT values were also *significantly different* ($p \approx 0.000$), with the TC group averaging a distance nearly 90% longer than the control group. The VMT figures show that the difference in average VMTs per person-day are also *significant* ($p = 0.009$) for the two groups. The average VMT per personal vehicle-day for the telecenter users is nearly 85% more than that for the control group.

As is evident from the tests conducted above, significant differences exist between the telecenter users and the controls, and the two groups are not exactly comparable. It is interesting to note that the relationships observed between the two groups in this study (fewer trips but higher miles traveled for telecenter users) mirror previous results reported by a study of data from the Puget Sound region (Henderson and Mokhtarian, 1996). That study hypothesized that the higher PMT (and VMT) for telecenter users is probably due to a longer average commute length, and the smaller number of trips is due to the longer commute trip taking up time that could otherwise be used for discretionary trips. Those hypotheses fit the current study as well. The average one-way commute distance to the regular workplace, obtained from the 39 telecenter users for whom after attitudinal survey data was available, was 44 miles (see Section 3.2.2), more than twice as long as the control group average of 18 miles (obtained from 10 respondents for whom data was available on both the after travel diary and the after attitudinal surveys).

6.2.3 Telecenter Users on TC vs. NTC Days

Since the non-telecommuter group is not as comparable to the telecenter users as would be desired, we focus on the comparison between telecommuting and non-telecommuting days for telecenter users. The comparisons for the number of trips, PMT, and VMT are shown in Table 6-4. As was done in the previous comparisons, t-tests were conducted to identify significant differences between the two sets of days.

Table 6-4: Comparison of the Number of Trips, PMT, and VMT for Telecenter Users on Non-telecommuting and Telecommuting Days

Day Type	Person-days	Indicator Mean (Standard Deviation)	
		Trips per Person-day	PMT per Person-day
NTC Days	39	4.33 (2.51)	90.87 (44.06)
TC Days	30	4.20 (2.22)	23.20 (28.14)
	Pers. Vehicle (PV) days	PV Trips per Person-day	VMT per Person-day
NTC Days	39	2.26 (1.29)	58.91 (51.35)
TC Days	30	3.20 (1.32)	20.75 (27.99)

The average number of trips per person-day was found to be *statistically equal* for the two day types ($p = 0.819$), at slightly more than four trips per day. The average number of trips made by personal vehicles, however, were *significantly different* ($p = 0.004$). The mean PMT per person-day was found to be *significantly different* for the two groups ($p \approx 0.000$). The average PMT on TC days is more than 74% lower than on NTC days. As expected, the VMT indicator follows the outcome seen for PMT demonstrating significant differences between the two sets of days ($p \approx 0.000$). A reduction of nearly 65% in average VMT per person-day on TC days was observed. Comparing the PMT to the VMT values and the values for average number of trips and average number of PV trips, the insignificant difference in the values for the TC day type is interesting. This seems to imply a very skewed mode choice distribution on telecommuting days, indicating that most telecenter users tend to employ their personal vehicles to make a majority of their trips on telecommuting days. This observation will be corroborated by findings in the mode choice sections (see Section 6.3).

From Section 6.2.2, the comparison between telecenter users and control group members shows that telecenter users have a larger average daily PMT (and VMT) on NTC days compared to the control group. In this section, the comparison reveals that these PMT and VMT figures fall considerably (74 and 65%, respectively) on telecommuting days. It is of interest to compare the travel activity of the telecenter users on telecommuting days to that of the non-telecommuters (see Table 6-5).

Table 6-5: Comparison of the Number of Trips, PMT, and VMT for Non-telecommuters and Telecenter Users on Telecommuting Days

Group	Person-days	Indicator Mean (Standard Deviation)	
		Trips per Person-day	PMT per Person-day
Non-TCers	31	5.90 (3.77)	47.86 (34.09)
TCers on TC days	30	4.20 (2.22)	23.20 (28.14)
	Pers. Vehicle (PV) days	Vehicle Trips per PV day	VMT per PV day
Non-TCers	31	1.84 (1.72)	31.85 (32.29)
TCers on TC days	30	3.20 (1.32)	20.75 (27.99)

The difference between the average number of trips for the two groups is *significant* ($p = 0.036$), with the non-telecommuter group making a higher number of trips per person-day. The difference between the number of drive alone trips made by personal vehicles for the two groups is also *significant* in the same direction ($p = 0.001$). The PMT values are also *significantly different* ($p = 0.003$), with the telecenter users on TC days traveling nearly 52% shorter distances using all modes than non-TCers. The VMT values, however, are not significantly different between the two groups ($p = 0.156$), although VMT for telecenter users on TC days is about 35% lower, than non-TCers' VMT.

To summarize these comparisons, while telecommuters on ordinary commuting days travel, on average, 47% more miles than the control group members, they travel 52% *less* than the controls on TC days. Given that the non-telecommuters made more trips than telecommuters on NTC days, it is not surprising that they still made more trips than telecommuters on TC days. All three indicators, but especially PMT and VMT, point to considerable savings in travel, not just against telecommuters' own extreme baseline, but against a more typical employee's travel behavior on an average workday.

6.2.4 Trip Distribution Characteristics

Having studied the average number of trips per person-day by group and by day type, we now look at the number of trips in more detail by analyzing the impact of telecommuting on their distribution with respect to time of day and trip purpose. Next, the impact of telecommuting on trip chaining will be explored by comparing the number of links per trip chain.

6.2.4.1 Trip Distribution by Time of Day

The primary hypothesis with regard to the temporal distribution of trips is that *telecommuters will reorganize their trips in order to avoid rush hour traffic.* Figures 6-4a and b show the distribution of trips in our sample by time of day. The distribution has several interesting features that merit discussion. Considering first the trip start times, we see a clear ordering of the three groups, with the telecenter users on non-telecommuting days (TC-NTC) tending to start earliest (in the 5 - 7 AM window), the non-telecommuters (Non-TC) tending to start next and telecenter users on telecommuting days (TC-TC) tending to start latest (in the 7 - 8 AM window). This ordering is quite logical, with the members of the TC-NTC group starting first because of their long commute to work and the members of the TC-TC group starting last because of their short commute to the telecenter (see Section 3.2.2). The other interesting feature of the distribution is the significant lunch time peak for telecenter users on telecommuting days. This could be correlated with the significant proportion of eat meal and return home trips observed for this group (Purposes 2 and 6, see Figure 6-4c). Finally, the TC-TC group members seem to start their final return home trip in the evening before the other two groups, with very few of the telecenter users starting trips after 7 PM. In total it appears that travel on working days for the TC-TC group is considerably compressed (5 AM to 7 PM) in comparison with the TC-NTC group (4 AM to 9 PM) or the control group (5 AM to 9 PM).

Chi-squared tests of independence were performed to see if the distributions were statistically different between the three groups. A very small χ^2 value indicates that the distributions compared are not significantly different, while a high χ^2 value (and hence a small p-value) would indicate otherwise. To account for low cell counts in certain time windows, the categories were aggregated into two hour time windows with the tails of the distribution being aggregated into larger windows due to the sparse distribution of trips in the early morning and late night hours of the day. The aggregated distribution is given below in Table 6-6 and the test results are discussed below.

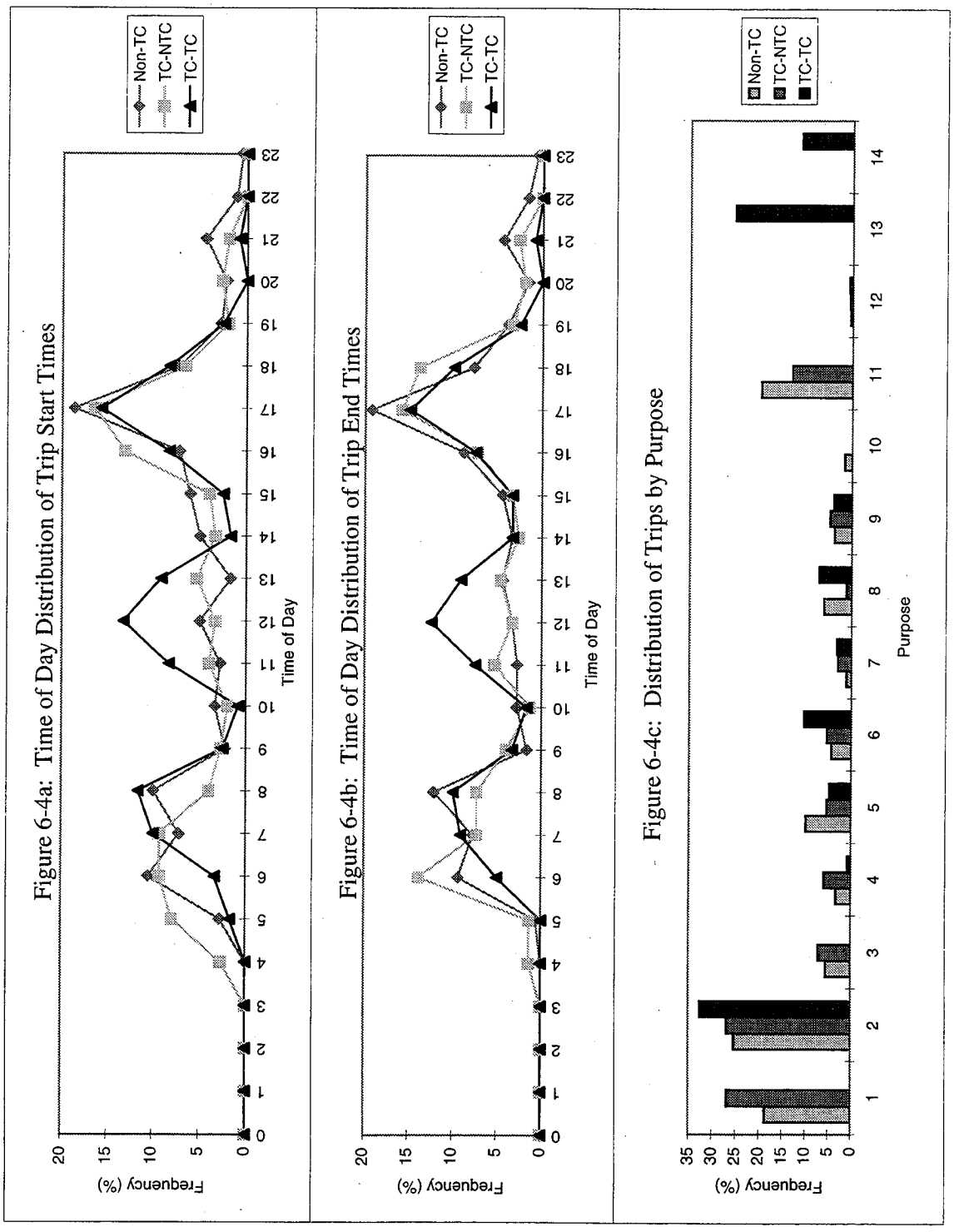


Figure 6-4a: Time of Day Distribution of Trip Start Times
Non-TC
TC-NTC
TC-TC
Frequency (%)
Time of Day
Figure 6-4b: Time of Day Distribution of Trip End Times
Non-TC
TC-NTC
TC-TC
Frequency (%)
Time of Day
Figure 6-4c: Distribution of Trips by Purpose
Non-TC
TC-NTC
TC-TC
Frequency (%)
Purpose

Table 6-6: Aggregated Trip Start and End Times

Time Window	Trip Start Times			Trip End Times		
	Non-TCers	TCers on NTC days	TCers on TC days	Non-TCers	TCers on NTC days	TCers on TC days
12 - 6 AM	5	16	2	1	4	1[1]
6 - 8 AM	32	28	16	31	32	17
8 - 10 AM	22	10	17	25	17	16
10 - 12 PM	11	9	11	10	10	11
12 - 2 PM	12	13	27	14	12	26
2 - 4 PM	20	11	5	14	9	8
4 - 6 PM	47	45	29	51	35	27
6 - 8 PM	18	13	13	21	26	15
8 - 11 PM	15	7	1	15	7	1
Total	182	152	121	182	152	122

[1] This cell was originally empty but was set equal to 1 in order to calculate the χ^2 statistic.

For trip start times, the distributions for the non-telecommuters and the telecenter users on regular commute days were found to be statistically identical ($p = 0.068$), while the distribution of trips on telecommuting and non-telecommuting days for telecenter users were found to be significantly different ($p \approx 0.000$). Similar results were obtained for the trip end time distributions, with statistically identical distributions for the non-TC and TC-NTC groups ($p = 0.398$) and significantly different distributions for the TC-NTC and TC-TC groups ($p = 0.029$.) Thus, while non-telecommuters and telecenter users on non-telecommuting days tend to distribute their trips similarly, on telecommuting days the distribution is significantly different.

A previous study of home-based telecommuting (Pendyala, *et al.*, 1991) found that the apparent shifts in the temporal distribution were actually due to overall reductions in trips occurring disproportionately in certain time periods. Specifically, commute trips were eliminated from the AM and PM peaks, thereby altering the relative distribution of trips, but trip-making for other purposes and in other time periods did not change significantly. PMT and VMT, on the other hand, were reduced across all time periods (Koenig, *et al.*, 1996). Here by contrast, since the number of trips is not appreciably different between TC and NTC days, differences in the temporal distributions reflect actual shifting of trips. The implication is that telecenter users *do* move their trip start times around (by compressing their work day) in order to avoid the rush hour traffic, confirming the hypothesis stated earlier.

6.2.4.2 Trip Distribution by Purpose

Having explored the temporal distribution of trips, we will now discuss the distribution of trips according to purpose. Following a methodology similar to the one previously described, frequency distributions of trips according to purpose were obtained (see Figure 6-4c). Once again, several categories had to be aggregated due to low cell counts. The following categories were merged: 1 and 13; 3 and 14; and 9, 10, and 12. The aggregated frequency distribution and the results of the χ^2 tests of independence are given below (see Table 6-7).

The following key will aid in interpreting Figure 6-4c:

Purpose 1	Commute to Work	Purpose 8	Social / Recreation
Purpose 2	Return Home	Purpose 9	Personal Business
Purpose 3	Return to Work	Purpose 10	School / Education
Purpose 4	Work-related	Purpose 11	Change Mode
Purpose 5	Drop Off / Pick Up Passenger	Purpose 12	Other
Purpose 6	Eat Meal	Purpose 13	Commute to Telecenter
Purpose 7	Shopping	Purpose 14	Return to Telecenter

Table 6-7: Aggregated Frequency Distribution of Trips by Purpose

Purpose	Non-TCers	TCers on NTC days	TCers on TC days
1/13. Commute to work / telecenter	34	41	31
2. Return home	46	40	39
3/14. Return to work / telecenter	10	10	13
4. Work-related	6	10	1
5. Drop off / pick up passenger	18	9	6
6. Eat meal	8	9	13
7. Shopping	2	5	3
8. Social recreation	11	1	9
11. Change mode	36	20	1[1]
9/10/12. Other	11	7	6
Total Trips	182	152	122

[1] This cell was originally empty but was set equal to 1 in order to calculate the χ^2 statistic.

The χ^2 test of independence indicates that the distributions for the control and TC-NTC groups are significantly different ($p = 0.039$), and the TC-NTC and TC-TC groups are even more significantly different ($p \approx 0.000$). Figure 6-4c brings to light some interesting details about the distributions. We see that there are significantly higher proportions of *return home* (2) and *eat*

meal (6) trips on telecommuting days, as was discussed earlier. Also, there are no *change mode* trips on telecommuting days, while a significant proportion of the trips for the other two groups belong in the *change mode* purpose. The implication is that a smaller variety of modes are used on TC days, with most of the trips made using personal vehicles. This corroborates the conclusions drawn in Section 6.2.3 while comparing the travel indicators for non-telecommuters and telecenter users on telecommuting days. On telecommuting days we also observe higher proportions of *shopping* and *social / recreation trips*, which might have some interesting behavioral implications.

6.2.4.3 Trip Chaining

Finally, the extent of home-based trip chaining for telecenter users on telecommuting and non-telecommuting days was studied. The number of links in the home-to-home chain was used as an indicator of the degree of trip chaining. On non-telecommuting days there were 3.5 links per chain on average, compared to 2.7 links per chain on telecommuting days. This is consistent with the finding of Pendyala, *et al.* (1991) that the proportion of single-stop chains increased on telecommuting days. Perhaps, since the average commute on non-telecommuting days is rather long (79 miles), very few people tend to come home in the middle of the work day, and a considerable amount of trip chaining takes place on the long commute. On the other hand, on telecommuting days, the respondents tend to make a few more home-home chains with each chain having relatively fewer links since the telecenter is closer to home. Dividing by the average number of trips per person-day shown in Table 6-4 yields an average of 1.2 and 1.5 chains per day on NTC and TC days, respectively. A χ^2 test shows that the distribution of the number of links (see Table 6-8) is significantly different on NTC and TC days ($p = 0.049$).

Table 6-8: Distribution of the Number of Links in Home-Home Chains for Telecenter Users

Number of Links	NTC Days	TC Days	Number of Links	NTC Days	TC Days
1	5	3	6	5	1
2	35	24	7	4	0
3	10	5	8	2	0
4	13	11	9	2	0
5	2	2	11	2	0

6.2.5 Comparison of Commute and Non-commute Travel

A detailed analysis of the after travel diary was performed to study the impact of telecommuting on both commute and non-commute travel. Since there is a potential for an increase in non-commute travel due to telecommuting (Salomon, 1985), the primary motivation for the analysis was to determine how the reduction in PMT and VMT, and the marginal reduction in trips (see Section 6.2.3), were distributed between commute and non-commute purposes.

A C program was developed to split PMT, VMT, and the number of trips per person-day into commute and non-commute purposes. To calculate commute PMT, the travel diary data were first scanned to check for direct home-to-work trips. If a direct home-to-work (or home-to-telecenter on telecommuting days) trip entry was present on any of the days, the corresponding distance was taken as the commute distance for that person. Otherwise, the commute distance reported in the attitudinal survey was used. Calculating the commute VMT was more complicated since it could vary by day for the same person, so it had to be identified separately for each trip. For a home-to-work sequence in which not all links were drive alone, the commute VMT was the minimum of the length of drive alone link(s) and the direct home-to-work commute distance from the attitudinal survey or from other travel diary days. The program calculates on an individual basis the total PMT, total VMT, total trips, and the number of commute trips per person-day (for a home-to-work-to-home chain, two commute trips are counted), using the following equations:

non-commute trips/person-day = total trips/person-day - commute trips/person-day,

non-commute PMT/person-day = total PMT/person-day - commute PMT/person-day,

non-commute VMT/person-day = total VMT/person-day - commute VMT/person-day,

commute PMT/person-day = commute trips/person-day × commute distance, and

commute VMT/person-day = total commute VMT / total number of person-days,

$$\text{commute VMT/person-day} = \frac{\text{total commute VMT}}{\text{total number of person-days}}.$$

The above measures were calculated for non-telecommuting days and telecommuting days (see Table 6-9). There is a drastic reduction in the commute PMT and VMT on telecommuting days which is not surprising since the commute distance of telecenter users to the regular workplace is much greater than to the telecenter. More interestingly, the table shows that the non-commute PMT actually decreases by almost a mile on telecommuting days, though the difference is not statistically significant ($t = 0.14$; $p = 0.89$). This is a positive result from a transportation viewpoint, which counters the hypothesis that non-commute travel increases on telecommuting days. However, though non-commute PMT decreases on telecommuting days, non-commute VMT actually increases by three miles on telecommuting days. Again, the difference is not statistically significant ($p = 0.57$). Figure 6-5 shows how the non-commute distance is distributed between drive-alone and all other modes on telecommuting and non-telecommuting days. There seems to be a decrease in the non-vehicular non-commute travel on telecommuting days.

Though the average numbers of trips on both non-telecommuting and telecommuting days are almost equal ($t = 0.23$; $p = 0.82$), the distribution of trips between commute and non-commute purposes is different. Contrary to original expectations, on telecommuting days, there is a statistically significant increase of 0.5 commute trips ($t = 2.75$; $p = 0.01$). The primary reason for this increase appears to be telecenter users going home for lunch more often on telecommuting days (see Section 6.2.4.2). (Going to the regular workplace on a telecommuting day was not a major effect, since that only occurred once in the sample as shown in Figure 6-3). The table also shows that there is a decrease of 0.6 non-commute trips on telecommuting days, though the difference is not statistically significant ($t = 1.04$; $p = 0.29$).

Table 6-9: The Impact of Telecommuting on Commute and Non-commute Trips, PMT, and VMT[1]

Trips/Person-day	Non-telecommuting Days	Telecommuting Days
Total	4.3	4.2
Commute	**1.8**	**2.3**
Non-commute	2.5	1.9
PMT/Person-day		
Total	**90.9**	**23.2**
Commute	**79.0**	**12.1**
Non-commute	11.9	11.1
VMT/Person-day		
Total	**58.9**	**20.8**
Commute	**53.1**	**12.1**
Non-commute	5.8	8.7

[1] Bolded means are significantly different between telecommuting and non-telecommuting days at $\alpha \leq 0.05$.

6.2.6 Aggregate Analysis

So far we have been analyzing the different day types separately. In the discussion that follows, various results are combined to obtain a more holistic view of the overall travel impacts of telecommuting for telecenter users. Telecommuting as a work option is not likely to replace conventional work schedules completely but will only occur for a certain percentage of days in a work week. To account for this, we compute the weighted average of travel indicators on TC and NTC days, where the weights are the relative frequencies of each type of day.

Specifically,

$$G_{AGG} = \frac{\sum_i G^i}{N}, \tag{6.1}$$

$$G^i = G^i{}_{TC} f^i{}_{TC} + G^i{}_{NTC} f^i{}_{NTC} + G^i{}_{HB} f^i{}_{HB}, \tag{6.2}$$

$$G^i{}_{XX} = \frac{\sum_i g^i{}_{XX}}{N^i{}_{XX}},$$

$$f^i{}_{XX} = \frac{N^i{}_{XX}}{N^i{}_{TC} + N^i{}_{NTC} + N^i{}_{HB}}, \text{ and}$$

$$f^i{}_{TC} + f^i{}_{NTC} + f^i{}_{HB} = 1,$$

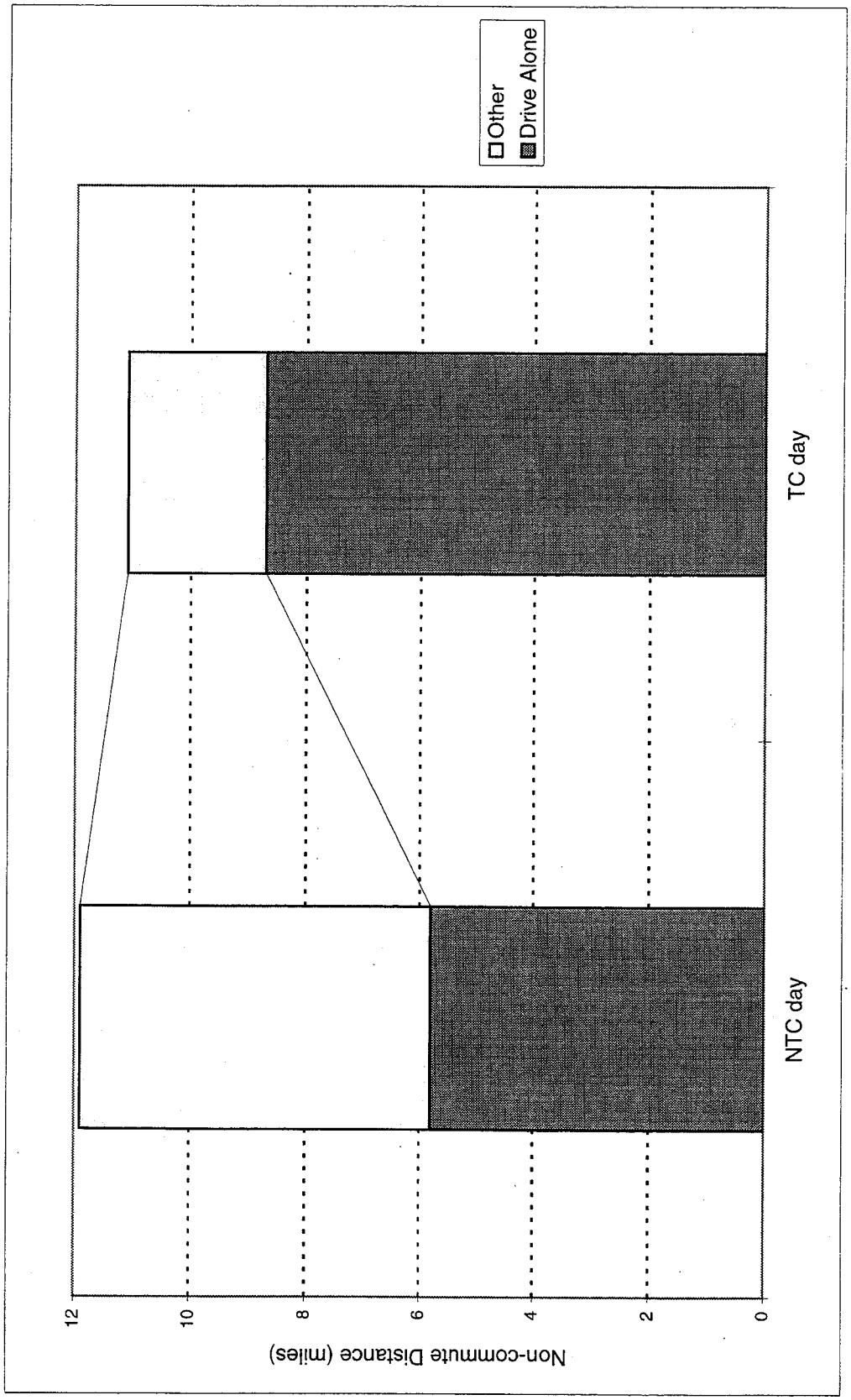


Figure 6-5: Distribution of Non-commute Distance Between Drive Alone and All Other Modes

where

G_{AGG} is the aggregate value of a generic travel indicator (number of trips, PMT, etc.),
G^i is the weighted average of the generic travel indicator for individual i,
N is the total number of respondents,
G^i_{XX} is the simple average of the travel indicator for the day type XX (TC, NTC, or HB) for respondent i,
g^i_{XX} is the value of the travel indicator for the ith respondent on some day of type XX,
N^i_{XX} is the number of days of type XX for respondent i, and
f^i_{XX} is the frequency of occurrence of day type XX for respondent i.

Note that the value of G_{AGG} as obtained from equation 6.1 above would not be the same as the value obtained by simply replacing each element of equation 6.2 with its sample average because, by averaging first at the individual level, one is accounting for any non-linear interactions that are likely to exist between the frequencies and the values of the travel indicators. For this study, however, the last term corresponding to telecommuting from home will be neglected as it constitutes a relatively insignificant portion (3 out of 72 person-days) of the telecenter users' person-days. Using equation 6.1, the aggregate values of the number of trips, PMT, and VMT are calculated (see Table 6-10). For non-telecommuters, $f^i_{TC} = f^i_{HB} = 0$, and $G^i = G^i_{NTC}$ For telecommuters, $f^i_{HB} \approx 0$ and $f^i_{NTC} = 1 - f^i_{TC}$. The values of the individual telecommuting frequencies used in these calculations have been taken from the six-month sign-in log average for each person (see Section 4.4).

Table 6-10: Comparison of the Aggregate Number of Trips, PMT, and VMT for Non-telecommuters and Telecenter Users

Study Group	Trips per Person-day	PMT per Person-day	PV trips per Person-day	VMT per Person-day
Non-TCers	5.85	49.13	1.89	32.91
TCers (current)	4.32	73.08	2.36	49.04
TCers (if no telecommuting)	4.28	90.45	2.16	59.42

The figures above indicate that at current telecommuting frequencies the aggregate average PMT and VMT are still significantly higher for center-based telecommuters than for non-telecommuters. This is because (1) the average non-telecommuting day PMT (and VMT) for telecenter users is considerably higher than for non-telecommuters (see Table 6-3), (2) the telecommuting frequency, f_{TC}, is not high enough to counter this difference in PMT (and VMT), and (3) neglecting home-based telecommuting inflates (albeit marginally) the proportion of non-telecommuting days.

The figures in Table 6-10 may be misleading in the sense that they *seem* to suggest that, in the aggregate, there are no positive travel impacts of telecommuting. However, in comparing the aggregate impacts of telecenter users to their own non-telecommuting baseline, the benefits of telecommuting *for this group of long-distance commuters* becomes clear. These results are shown

in the final row of Table 6-10 for the no-telecommuting scenario. With the current levels of telecommuting, there is a reduction of more than **19%** in average PMT (from 90 to 73 miles per person-day) when compared to the no-telecommuting alternative. Similar significant reductions can be observed in VMT (17%) too.

If no interactions existed between the frequency of telecommuting and the travel indicators, one could model the problem by taking a weighted average at the group level instead of the individual level. That is, the aggregate value of the travel indicator could be calculated as:

$$G_{AGG} = G_{TC}F_{TC} + G_{NTC}F_{NTC} + G_{HB}F_{HB} \tag{6.3}$$

$$G_{XX} = \frac{\sum_i g^i_{XX}}{N_{XX}}$$

$$F_{XX} = \frac{\sum_i f^i_{XX}}{N}$$

$$F_{TC} + F_{NTC} + F_{HB} = 1$$

where

G_{XX} is the value of the travel indicator averaged over all days of type XX and
F_{XX} is the sample average frequency of the occurrence of day type XX.

Comparing the formulation of equation 6.1 with equation 6.3, it is apparent that the latter is biased since when there are interactions between travel and frequency, the mean of the product (that is, equation 6.1, the correct formulation) will not equal the product of the means. This approximate formulation, however, allows us to examine some interesting "what-if" scenarios. In the hypothetical results presented below, an F_{TC} value of 0.182 (that is, an 18.2% frequency of telecommuting, obtained from the six-month sign-in log average), an F_{NTC} value of 1 - 0.182 = 0.818, and an F_{HB} value set equal to zero have been used. Due to the approximation alluded to above, the true values for the bolded statistics below are likely to be smaller for the first two and larger for the last one. Hence, they probably represent conservative bounds on the true values.

- The telecommuting frequency needed for the telecommuters to have a PMT equivalent to the non-telecommuters given the current travel parameters: **63.6%**. That is, telecenter users in the sample would have to telecommute more than three days per week on average, in order for their aggregate PMT to decrease to the same level as that of the non-telecommuters in the sample.
- The non-telecommuting day PMT for telecenter users so that their aggregate PMT at the current average telecommuting frequency of 18.2% is equivalent to the non-telecommuters': **53.4 miles**. That is, if telecenter users maintained their current average frequency of 18.2%, their non-telecommuting day PMT would need to average 53.4 miles (compared to 90.9 miles currently) in order for their aggregate PMT to drop to the level of the non-telecommuters.
- The reduction achieved in aggregate PMT assuming the same average VMT for telecommuters and non-telecommuters on non-telecommuting days: **9.4%**. That is, if telecenter users' PMT on non-telecommuting days were equivalent to that of non-telecommuters (47.9 miles) and their

telecommuting day PMT remained at 23.2 miles, their aggregate PMT would be 43.4 miles, a 9.4% reduction over the non-telecommuting baseline of 47.9 miles.

These hypothetical scenarios highlight the need for caution in extrapolating the observed results to the population as a whole. First, the question of selection bias should be addressed. Participation in the study as a non-telecommuting control group member was completely voluntary, and while recruitment was not rigorously random, travel indicators for this group appear to be reasonably representative. Participation as a telecenter user was also voluntary, and hence the data seem to suggest that telecommuting is most attractive to those with long commutes. This inference is quite intuitive and has been reported in other studies (Mokhtarian, *et al.*, 1995).

However, while the evaluation team made no such request, it may be the case that employers selected telecommuting participants in this demonstration project partly on the basis of their commute length. This possibility, plus the fact that at least three-quarters of the non-telecommuting group expressed a desire to telecommute, suggest that commute length is not the only motivation in a *preference* to telecommute although it may be a key factor in the early adoption of telecommuting.

The implications for predicting and marketing telecommuting are important. From a market research perspective, the results would indicate that the potential market for early adopters of telecommuting may be primarily those people who live beyond a certain threshold distance from their regular workplace. However, more typical commuters should not be permanently neglected as a potential market.

As for the impacts of telecommuting on travel, two scenarios can be envisaged – one at each end of the continuum – with the reality falling somewhere in between. At one extreme is the scenario that telecommuting continues to be adopted primarily by long-distance commuters only. Even with this restriction, telecommuting has significant travel benefits because respondents commute much shorter distances to telecommuting centers than to the regular workplace as illustrated in Table 6-9. But when spread over the entire population, the benefits will be attenuated. At the other extreme is the scenario that telecommuting is adopted across the spectrum of commute lengths, such that the average commute length of telecommuters is equivalent to that of non-telecommuters. There too, telecommuting will have significant travel benefits, but the per capita reduction will not be as large as those seen here, perhaps closer to the 9% reduction in overall PMT per telecommuter estimated above for the hypothetical scenario in which telecommuters and non-telecommuters had the same VMT on non-telecommuting days, rather than the 19% observed for this sample of long-distance commuters. In either case, then, the ultimate population impacts of telecommuting will be lower than those suggested by this sample, either because telecommuting will only be adopted by a smaller segment of the population than initially envisioned or because the per-capita impacts will diminish as adopters become more representative, or both.

Thus, while the travel reductions observed here are clearly beneficial to the participating individuals, the system-wide effects will depend on how broadly telecommuting is adopted and by whom. In addition, other factors have not been and could not be addressed in this study, which could potentially mitigate the travel benefits; these factors include latent demand for travel and long-run impacts on land use.

6.3 Commute Mode Choice

This section analyzes the impact of telecommuting on the commute mode choice of telecenter users by comparing mode choices on telecommuting and non-telecommuting days. Two types of impacts may be hypothesized (Mokhtarian, 1991). First, on telecommuting days the proportion of transit and rideshare commute trips may be lower than on non-telecommuting days. This is because the commute trip to the telecenter is shorter and perhaps less well-served by the established transit systems and rideshare programs that focus on serving major employment centers. The second hypothesis is that commute trips to the telecenter (again because they are shorter) are more likely to involve environmentally-beneficial modes such as walk and bike.

The commute mode patterns of telecenter users are available from two primary sources, namely, the travel diaries and the attitudinal surveys. (In addition, commute modes on telecommuting days are identified in the sign-in log data, but distances traveled by each mode are not recorded there). Specific commute mode patterns are obtained from the travel diary. However, the travel diary data constitute only a particular snapshot in time, which for this small sample may not be representative of the behavior of the respondents. On the other hand, the attitudinal survey data may be more representative since it elicits an average commute mode pattern – actually the two most common patterns, with the percent of time each pattern is used. But, the data from the attitudinal survey may not be completely accurate since it relies on recall and since some respondents may use more than two patterns. Further, the attitudinal survey data may be more subject to respondent bias than the actual behavior recorded in the diaries, as suggested in Section 6.3.3. We should, therefore, expect differences in the commute mode choices obtained from the two sources.

A commute trip could consist of multiple trip segments and could have more than one mode. Two methods were used to calculate the mode splits: the primary-mode method and the distance-based method. In the first method, the mode used for the longest portion of the commute trip is identified as the primary mode, and the percent of trips for which a given mode is primary is calculated. In the second method, a weighted average of all modes used in any commute trip is calculated, where the weights are the distances for which a given mode is used. Also, the mode split analysis for both methods focuses only on the home-to-work trip since the trip to work is less likely to be contaminated with side trips than the trip home.

6.3.1 Commute Mode Choice from the Travel Diary Data

A total of twenty-four telecenter users completed the three-day after travel diaries. Thus, the total number of person-days was 72, out of which 39 were classified as non-telecommuting, 30 were telecenter-based telecommuting, and three were home-based telecommuting days (see Section 6.2.1 for the definition of each day type). However, not all non-telecommuting person-days involved a home-based commute trip. On two person-days, respondents did not work, and on two other person-days, the commute trip did not originate at home. Thus, the non-telecommuting day results presented below are based on the 35 person-days involving a regular commute trip. These 35 days actually comprise 36 commute trips, as individuals could go home and return to work sometime later in the day. Similarly, the 30 telecommuting person-days involved 34 commute trips to the telecenter.

A trip sequence was classified as a commute sequence if it originated at home and ended at either the regular workplace or the telecenter on the same person-day. Identifying the commute sequence was a non-trivial exercise since the number of segments in a commute sequence varies. A computer program was developed using the C language to identify the commute trips and evaluate the commute mode splits for telecenter users on telecommuting and non-telecommuting days.

Table 6-11 shows that on telecommuting days there is a substantial increase in the proportion of drive-alone commute trips. Also, as hypothesized, on telecommuting days the proportions of transit and rideshare commute trips decline, and the proportion of walk commute trips increases marginally. From the data, we can also determine that the number of segments per commute trip on telecommuting days (1.06) is lower than on non-telecommuting days (1.78). This is not surprising since the commute distance to the telecenter is significantly shorter than the commute distance to the regular workplace so there are fewer opportunities for trip-chaining. Another interesting observation was that on each of four (13%) telecommuting person-days, two commute trips were made to the telecenter. These additional trips home and back to work during the day are probably the result of having a shorter commute distance on telecommuting days. This result is discussed further in Sections 6.2.3 and 6.2.5.

Table 6-11: Commute Mode Split on Telecommuting and Non-telecommuting Days

Mode[1]	Primary Mode Split		Distance-based Mode Split	
	NTC Days (36 trips)	TC Days (34 trips)	NTC Days (miles)	TC Days (miles)
Drive Alone[2]	24 (66.7%)	33 (97.1%)	1054.9 (64.7%)	182.2 (99.4%)
Carpool/Vanpool[2]	8 (22.1%)	0	385.2 (23.6%)	0.7 (0.4%)
BART/Metro Red Line	0	0	17.5 (1.1%)	0
Commuter train	4 (11.2%)	0	158.0 (9.6%)	0
Walk	0	1 (2.9%)	1.0 (0.1%)	0.4 (0.2%)
Other	0	0	14.0 (0.9%)	0.00

[1] The following mode options were given in the diary but never selected by the respondents: drove/rode in electric vehicle, bus, light rail/trolley, and bicycle.

[2] Mode categories differed slightly between the travel diary and the attitudinal survey. To make the diary categories consistent with those on the attitudinal survey, the mode category "drove conventional motor vehicle" was split into "drive alone" and "carpool/vanpool" based on the number of people in the vehicle. The mode was considered to be "carpool/vanpool" if the number of people in the vehicle was greater than one. Also, the mode category "rode in conventional motor vehicle" was merged with the "carpool/vanpool" category.

It is interesting to note that the commute mode choices on telecommuting days obtained from the travel diaries are quite different from those obtained from the sign-in log data (Section 4.3.3). The percentage of drive-alone commute trips on telecommuting days obtained from the travel diaries (97.1%) is substantially higher than the percentage obtained from the sign-in log data (77.1%). A couple of reasons could explain this difference. Firstly, the sign-in log data is inherently weighted by the frequency of telecommuting whereas the travel diaries are less representative of actual frequencies. So, frequent telecommuters, who have a higher representation in the sign-in log data, could be making fewer drive-alone commute trips. Secondly, the two groups of people, travel diary respondents and sign-in log respondents, are not identical.

6.3.2 Commute Mode Choice from the Attitudinal Survey Data

6.3.2.1 NTC Day vs. TC Day Comparison

Data obtained from the 39 telecenter users who completed the after employee surveys were used to analyze the commute mode choices on telecommuting and non-telecommuting days. Questions D8 and D9 of the after employee survey ask for up to two patterns that telecenter users most often use to get to their regular workplace and telecommuting center respectively (see Appendix E). These questions obtain information on the mode used for each segment of the commute trip, the approximate length in miles of each segment, and the percent of time respondents use each pattern in terms of *the total number of days that they commute to their regular workplace* (or *the total number of days that they work from the telecommuting center*). Since the frequency with which each person works at home, the telecenter, and the regular workplace varies, it is important in obtaining aggregate mode choices to weight the above percentages by the frequency with which each individual commutes to the regular workplace and to the telecenter, respectively. For example, in calculating aggregate mode choices on telecommuting days, the pattern(s) of a person who telecommutes (from a center) 40% of the time should receive twice as much weight as those for a person who telecommutes 20% of the time.

As was discussed at length in Section 4.4.3, the frequency with which each respondent currently telecommutes from a center (f_{TC}) is obtained from three sources, namely, the attitudinal survey, six-month sign-in log data, and one-month sign-in log data. The frequency with which each respondent currently telecommutes from home (f_{HM}) is obtained from the attitudinal survey question (D11b, see Appendix E), "How much do you currently telecommute from home?" The frequency with which a person works from a regular workplace (f_{RW}) is therefore: $(1 - f_{TC} - f_{HM})$. Tables 6-12 and 6-13 show the resulting commute mode splits obtained after weighting the data with the telecommuting frequencies using three data source combinations: AS (uses the attitudinal survey data for modes and f_{TC}), SIL6 (uses the attitudinal survey for modes and the six-month sign-in log data for f_{TC}), and SIL1 (uses the attitudinal survey for modes and the one-month sign-in log data for f_{TC}).

Table 6-12: Primary Mode Split by Data Source

Mode	Non-telecommuting Days			Telecommuting Days		
	AS	SIL6	SIL1	AS	SIL6	SIL1
Drive Alone	61.90%	64.92%	64.18%	82.58%	80.45%	76.86%
Carpool	5.57%	5.85%	5.47%	6.98%	8.76%	11.63%
Bus	10.10%	8.05%	9.60%	0.00%	0.00%	0.00%
Walk	0.00%	0.00%	0.00%	2.61%	2.17%	3.08%
Bike	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Train	5.84%	4.79%	4.96%	0.00%	0.00%	0.00%
Vanpool	13.62%	13.60%	13.05%	0.00%	0.00%	0.00%
BART	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Light Rail	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Missing	2.97%	2.79%	2.74%	7.83%	8.62%	8.43%
Test Results	χ^2 = **0.487** Critical χ^2 (8, 0.05) = 15.547			χ^2 = **1.615** Critical χ^2 (6, 0.05) = 12.592		

Table 6-13: Distance-based Mode Split by Data Source

Mode	Non-telecommuting Days			Telecommuting Days		
	AS	SIL6	SIL1	AS	SIL6	SIL1
Drive Alone	64.91%	66.96%	64.50%	87.03%	83.87%	81.36%
Carpool	5.17%	5.25%	5.14%	7.73%	9.04%	12.53%
Bus	7.16%	6.12%	7.53%	0.00%	0.00%	0.00%
Walk	0.04%	0.05%	0.06%	0.37%	0.38%	0.33%
Bike	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Train	4.45%	3.61%	4.06%	0.00%	0.00%	0.00%
Vanpool	14.12%	13.79%	14.25%	0.00%	0.00%	0.00%
BART	0.72%	1.02%	1.05%	0.00%	0.00%	0.00%
Light Rail	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Missing	3.43%	3.20%	3.41%	4.87%	6.71%	5.78%
Test Results	χ^2 = **0.388** Critical χ^2 (14, 0.05) = 23.685			χ^2 = **1.749** Critical χ^2 (6, 0.05) = 12.592		

From the above tables, it is clear that the percentage of drive-alone commute trips is substantially greater on telecommuting days than on non-telecommuting days. An interesting observation is that there is a slight increase in the proportion of carpool commute trips on telecommuting days. But, the overall rideshare (including vanpool) commute trips on telecommuting days has decreased. Also, there is a slight increase in the proportion of commute trips by walk on telecommuting days. A chi-squared test of the distributions shows no statistically significant differences among the mode splits obtained using the three data sets.

6.3.2.2 Before vs. After Comparison

A before and after comparison of the commute mode choices as reported in the employee surveys was done for the 27 respondents completing both surveys. In the case of non-telecommuting days, the comparison is a "true" before and after comparison of commute mode choices with a time interval of approximately six months. In other words, the analysis will reveal whether telecommuting has affected the commute mode choices of telecenter users on non-telecommuting days. It has been hypothesized, for example, that telecommuting might lead to the dissolution of carpools, resulting in more drive alone trips even on non-telecommuting days (Mokhtarian, 1991).

The before and after comparison on telecommuting days is actually a prospective vs. current comparison of commute mode choices. In the before employee surveys, the respondents were asked to give the commute mode pattern that they plan to use most often to get to the telecommuting center. The before commute mode pattern on telecommuting days was evaluated by weighting this pattern with the frequency of telecommuting obtained from the question, "Six months from now, how much do you expect to be telecommuting from a telecommuting center?" The after commute mode pattern was weighted by the current frequency of telecommuting reported in the attitudinal survey. Tables 6-14 and 6-15 show the comparison on both non-telecommuting days and telecommuting days.

From the following tables, the before and after commute mode splits are almost identical on non-telecommuting days, implying that telecommuting has not affected the commute mode choices of the respondents on non-telecommuting days. Also, the prospective and current commute mode choices on telecommuting days are very similar suggesting that the respondents had a fairly good idea (before they actually started telecommuting) of the commute modes they would be using to get to the telecenter.

Table 6-14: Primary Mode Split by Survey Wave (N=27)

Mode	Non-telecommuting Days		Telecommuting Days	
	Before	After	Before	After
Drive Alone	72.20%	71.74%	71.38%	79.01%
Carpool	4.16%	2.74%	11.96%	8.74%
Bus	2.63%	6.56%	1.24%	0.00%
Walk	0.00%	0.00%	3.30%	4.04%
Bike	0.00%	0.00%	0.00%	0.00%
Train	0.00%	0.00%	0.00%	0.00%
Vanpool	19.44%	16.47%	0.00%	0.00%
BART	0.00%	0.00%	0.00%	0.00%
Light Rail	0.42%	0.00%	0.00%	0.00%
Missing	1.15%	2.49%	12.12%	8.21%
Test Results	χ^2 = **3.15** Critical χ^2 (5, 0.05) = 11.07		χ^2 = **2.95** Critical χ^2 (4, 0.05) = 9.49	

Table 6-15: Distance-Based Mode Split by Survey Wave (N=27)

Mode	Non-telecommuting Days		Telecommuting Days	
	Before	After	Before	After
Drive Alone	72.87%	73.57%	74.91%	84.75%
Carpool	4.06%	1.83%	17.22%	9.09%
Bus	2.57%	2.73%	0.36%	0.00%
Walk	0.01%	0.06%	0.23%	0.44%
Bike	0.00%	0.00%	0.00%	0.00%
Train	0.00%	0.00%	0.00%	0.00%
Vanpool	18.98%	16.48%	0.00%	0.00%
BART	0.00%	1.18%	0.00%	0.00%
Light Rail	0.41%	0.00%	0.00%	0.00%
Missing	1.10%	4.15%	7.28%	5.72%
Test Results	χ^2 = **4.42** Critical χ^2 (8, 0.05) = 15.51		χ^2 = **3.73** Critical χ^2 (4, 0.05) = 9.49	

6.3.3 Comparison of Travel Diary vs. Attitudinal Survey Mode Split

The commute mode splits obtained from the two sources, namely travel diaries and after employee surveys, are not very similar. The travel diaries show a substantially greater percentage of drive-alone commute trips on telecommuting days. Conversely, the surveys show some expected use of light rail and some expected and actual use of bus on non-telecommuting days, whereas the travel diaries do not record any uses of these two modes. Several reasons could explain these differences. First, the two samples are not identical: only 22 people fall in the intersection of the 24 diary respondents and the 39 survey respondents. Second, the bus and light rail modes were used (or expected to be used) so infrequently that they may legitimately not have been used during the three-day travel diary period. Finally, it is also possible that respondents are more likely (consciously or subconsciously) to overstate their use of environmentally correct modes for the general question on the attitudinal survey than to deliberately falsify their actual behavior as recorded on the diaries.

6.4 Summary of Travel Characteristics

In this chapter the travel characteristics of the respondents were studied. Four main travel indicators, namely the number of trips, PMT (person-miles traveled), VMT (vehicle-miles traveled), and mode choice distributions, were studied. Two main sets of comparisons were made: the first between the control group of non-telecommuters and telecenter users on non-telecommuting days and the other between telecommuting and non-telecommuting days for telecenter users.

The control group was found to have significantly different travel characteristics than the telecommuting group, with the latter making fewer trips (4.3 compared to 5.9) but traveling longer distances (90.9 average weekday PMT compared to 47.9 miles for the control group), on average. The differences in PMT and VMT could be attributed to differences in commute distances, and the difference in number of trips could be linked to the fact that telecenter users are left with a significantly smaller amount of time for discretionary activities in view of their long commutes to the regular workplace.

Since the non-telecommuter group is not as comparable to the telecenter users as would be desired, we focus on the comparison between telecommuting days and non-telecommuting days for telecenter users. Comparing telecommuting days and non-telecommuting days, one finds that while the average number of trips are almost the same, PMT and VMT values are significantly different, with the average weekday distance traveled by all modes decreasing by more than 74% on telecommuting days. Also, telecommuters on telecommuting days showed a reduction of nearly 52% in PMT when compared with the controls. Thus, these results point to considerable savings in travel on telecommuting days, not just against telecommuters' own extreme baseline, but against a more normal employee's travel behavior on an average workday.

Next, the distribution of trips with respect to time of day and purpose was explored. Significant differences were found between the temporal distributions of trips on telecommuting days and non-telecommuting days. Comparisons of telecommuters' non-telecommuting days with the control group, however, showed no significant differences. The distributions exhibited an interesting ordering of trip start times with telecenter users on non-telecommuting days starting the earliest, followed by the control group, and then telecenter users on telecommuting days

(because of their significantly shorter commute distances). The temporal distribution for telecenter users on telecommuting days also showed a significant lunch time peak. Comparisons of the distribution of trip purposes indicated that the distributions for the control group and the telecenter users on non-telecommuting days were statistically different while those on telecommuting and non-telecommuting days were even more significantly different. The differences arose due to (1) a significantly higher number of *return home* and *eat meal* trips, (2) a higher proportion of *shopping* and *social/recreation trips*, and (3) an absence of *change mode* trips on telecommuting days. This last factor corroborates the conclusions drawn by comparing the travel indicators for non-telecommuters and telecenter users on telecommuting days (see Section 6.2.3) and the discussion on mode choice (Section 6.3), and implies that a smaller variety of modes are used on telecommuting days, with most of the trips made while driving alone.

To study the trip chaining behavior of the respondents, the average number of links in a home-home chain were compared for telecommuting and non-telecommuting days. The comparison revealed a significantly higher number of links on non-telecommuting days. This could be attributed to the long commute distances on such days. As the average number of trips is almost the same for the two sets of days, one could hypothesize that on telecommuting days the respondents make a larger number of home-to-home cycles involving a smaller number of links.

A comparison of commute and non-commute travel on telecommuting and non-telecommuting days showed that there is a drastic reduction in the commute PMT (by 66.9 miles) and VMT (by 41.0 miles) on telecommuting days. Also, the non-commute PMT decreases almost a mile on telecommuting days. However, non-commute VMT actually increases by more than two and a half miles on telecommuting days. Therefore, there is a decrease in the non-vehicular, non-commute travel occurring on telecommuting days.

Though the average numbers of trips on both non-telecommuting days and telecommuting days are almost equal, the distribution of trips between commute and non-commute purposes differs. On telecommuting days, there is a statistically significant increase of 0.5 commute trips. Also, there is a decrease of 0.6 non-commute trips on telecommuting days, though the difference is not statistically significant.

Next, the commute mode choice distributions for the study groups were analyzed. The travel diary and attitudinal survey data show that there is a substantial difference between the commute mode choices of telecenter users on telecommuting days and non-telecommuting days. The percentage of drive-alone trips is substantially higher and the percentages of transit and rideshare trips are substantially lower on telecommuting than on non-telecommuting days. Also, a before and after comparison of the commute mode splits reported in the attitudinal survey revealed that telecommuting has not affected the commute mode choices of the respondents on non-telecommuting days.

Finally, to obtain a better understanding of the overall process, the aggregate values of the travel indicators were studied. This was done by weighting the travel indicators by the corresponding telecommuting frequency. The aggregate figures indicate that at current frequencies of telecommuting (18.2% on average, or approximately once in five days), the telecenter users travel significantly larger distances: a composite weekday average of 73.1 miles compared to 49.1 miles for the control group. Two factors contribute to the difference in aggregate travel between telecenter users and the controls: (1) the non-telecommuting day PMT (VMT) for the telecenter

users is considerably larger than that for the controls, and (2) the level of telecommuting is not high enough to counter this difference. But, while the telecenter users still travel more than the control group members, they would have had an average PMT of 90.9 miles had they not been telecommuting. Telecommuting from a center reduced their total weekday travel nearly 19%.

It could be hypothesized that commute distance is an important factor in the preference to telecommute and that a self-selection bias occurred in the selection of the study groups, with respondents who lived farther away opting to be in the telecommuting group. However, the possibility that commute distance might have been a criterion *used by the employers* in selecting respondents for the telecommuting group (thus generating an unintentional bias) and the fact that at least three-quarters of the non-telecommuting group expressed a desire to telecommute suggest that commute length is not the only motivation in a preference to telecommute. If telecommuting is primarily attractive to long-distance commuters, considerable per capita reductions in travel will result, though only in a particular market segment. Conversely, if the appeal is more universal, the reductions in travel per capita are not likely to be as high as in this sample but would apply to a larger segment of the workforce.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7. SUMMARY AND CONCLUSIONS

7.1 Summary

In this chapter, we first summarize the key findings from the data collected through June 1995 (Section 7.1), then discuss additional analyses that could be performed on these and future data (Section 7.2), and finally interpret the results to date (Section 7.3).

This report is an interim evaluation of telecommuting center use and its impacts on work performance, job satisfaction, and travel behavior. To that end, four survey instruments were developed to measure telecenter use and its effects at both RABO (Residential Area-Based Offices) and non-RABO sites: an attitudinal survey, a travel diary, an attendance log, and an exit interview. The survey and diary were administered to participants once before and once after the start of telecommuting, the attendance log was used throughout the study period, and the interview was conducted when participants left the program. The results of the complex evaluation process were presented in five chapters: procedural issues in the evaluation process, attitudinal survey analysis, analysis of telecommuting patterns, analysis of telecommuting retention, and travel characteristics. Each of these chapters is summarized below.

7.1.1 Procedural Issues

The RABO Project not only provides information on the practice of telecommuting center use, it also provides valuable lessons in the process of evaluating the use of telecommuting centers. The procedural issues related in Chapter 2 dealt with contractual compliance, site usage measurement, and modification of the survey process. Since telecommuting centers are a relatively new concept, the lessons learned here will help later evaluation programs be more effective.

Changes to the contracts with site developers were necessitated by problems with data collection. Some contracts did not directly tie the university to the administrators of the telecenter which resulted in poor communication and inadequate survey response rates. At all centers, survey response rates that were lower than desired led to modifications of the center funding policies. Telecommuters were only counted in funding invoices if they had completed the required surveys. This new policy also emphasized that, while participation itself was voluntary, survey completion was a mandatory element of participation. Additional methods for improving survey collection included shifting the duties of survey distribution and collection from the site administrator to the Evaluation Manager for those centers who did not want to handle these activities.

A strict definition of telecenter occupancy was developed to ensure that the measured rate of telecommuting reflected the goals of the study. The monthly site occupancy rate calculated to assess compliance with contractual targets includes only the telecommuting occasions by project participants that lasted at least four hours. However, there were other meaningful (in terms of travel reduction) uses of the center that fell outside this narrow definition. As a result, uses by telecommuters for any length of time were documented and evaluated. Further, most sites set up at least some of their workstations for use by drop-in customers, and others specifically leased work space to particular companies (neither of those types of center users participated in the evaluation). Some participants who use the center as their primary place of business were

included as project participants even though their situation is quite different from the typical telecommuter from a large organization. These participants may not have managers or co-workers to participate in surveys, may not have travel reduction benefits, and during the demonstration period, may be unfairly subsidized in relation to other similar businesses in terms of office space costs. It is recommended that a screening process be used to give highest priority to those who are truly telecommuting while still allowing other uses to continue at the site since a diversity of clients is a key to long-term operation.

Other issues involved in the evaluation process included changes to the survey procedure. Originally, focus groups were to be used to identify any initial problems and concerns of both the telecommuters and their managers with the use of telecommuting centers. However, problems with timing and scheduling caused the focus groups to be dropped in favor of individual telephone interviews. Additionally, the availability of a videoconferencing room at some telecommuting centers led to the development of a usage log for these facilities. The information collected from the videoconference logs will be summarized for the final report.

7.1.2 Attitudinal Survey Analysis

Similar attitudinal surveys were administered to three groups of participants (telecenter users, home-based telecommuters, and non-telecommuters) and their managers at two points in time (before the start of telecenter use and approximately six months afterwards). These surveys collected data on attitudes toward telecommuting, work characteristics, travel characteristics, and demographic information. In the sections below, we respectively discuss results for the telecenter employee survey, the manager survey for supervisors of telecenter users, and a comparison of employee and manager responses.

7.1.2.1 Employee Survey Results

In this interim report, the description of the survey data is restricted to the telecenter users only. Primarily, the data from the after-wave surveys is used to characterize center-based telecommuters (sample size of 39). However, where appropriate, data from both before and after waves are utilized to highlight changes related to the use of telecenters (a reduced sample size of 27). A summary of the results from the six parts of the survey is provided below.

The section on demographics asked for general characteristics, such as age, income, and education. There are slightly more female telecenter users than male ones, and nearly half the sample is between the ages of 35 to 44 years. The average household size of three persons is consistent with the fact that more than half of the respondents have children under 16 years of age. Vehicle availability is high among the respondents with 2.3 vehicles per household and 1.4 vehicles per worker. The telecenter users are highly educated: about 30% have had additional schooling after college. Additionally, many of the participants have high incomes (about 70% have annual household incomes greater than $55,000).

Job characteristics varied among the center-based telecommuters. Slightly over half of the sample hold professional/technical positions which are usually easily adapted to telecommuting, and as a whole, they are experienced in their field with an average length of time in the profession of 10.2 years. Flextime schedules are popular among the telecenter users (used by nearly 65%).

Finally, the respondents spend a good portion of their workday working independently (47%) or remotely (18%), both of which are good indicators of positions with telecommutable tasks.

The responses from the attitudinal sections on job performance and satisfaction and work environment characteristics show primarily positive results. There is little change in performance or satisfaction characteristics between survey waves suggesting that working from a telecommuting center does not drastically change these factors. The only significant change was a slight drop in the perceived opinion of the supervisor on the telecommuter's ability to meet deadlines. The ratings on the statements about work characteristics also remained primarily the same between survey measurements. Distractions at the telecenter were slightly more of a problem than originally envisioned, but the average response on the after survey is still to disagree with the statement that distractions were a problem. Finally, the most important work characteristics to the respondents are working effectively, having needed equipment, and having work judged by the results.

The survey also measured the amount of telecommuting the telecenter users had done, are currently doing, and plan to do in the future. The average experience with telecommuting from a center was about one year at the time of the after survey, and about half also had experience with home-based telecommuting. On the other hand, about 40% of the respondents did not have the option to telecommute from home which indicates that centers may help spread the transportation and other benefits of telecommuting to a larger segment of the workforce. With the time saved by telecommuting, the respondents most often spend time with family or friends, get more sleep, and/or relax by themselves.

When distributing their work time for the ideal situation, the respondents preferred to work from the regular workplace and the telecenter about equal amounts, 40% to 45% of their time (each) on average. However, they actually reported telecommuting only about 30% of the time even though their jobs were suitable for telecommuting for about 40% of the time, on average (see Section 4.4.2 for actual telecommuting frequency based on attendance log data). The respondents predicted greater frequencies of future center-based telecommuting than current levels (38%), but that expected frequency was substantially lower than was reported on the before survey (50%). In addition, the results from the choice, preference, and expectation of telecommuting indicate that combined home and center telecommuting appears to be a popular option.

In the section on travel, the commute to the regular workplace was reported as 44.2 miles in length, while the commute length to the telecommuting center was given as 7.3 miles, on average. The resulting average commute travel savings by using the center *instead of* going to the main office for the after survey respondents is 36.9 miles. Despite the reduction in travel, the majority of travel to the telecenter is on freeways, suggesting that the centers are far from the average participant's residence. This is especially true of the respondents from non-RABO centers who have longer commutes than RABO telecommuters, on average, to both the regular workplace (53.1 vs. 39.1 miles) and the telecommuting center (9.1 vs. 6.5 miles). Additionally, telecenter use was not found to have much effect on residential relocation decisions in this short time frame.

The tabulations of the attitudinal surveys provide a good characterization of the telecommuting center users. However, the survey data will also be used to model the decision to adopt telecommuting. Further analysis will be presented in the final report and/or in subsequent studies.

7.1.2.2 Manager Survey Results

This section summarizes the survey results from 28 supervisors of center-based telecommuters. On the whole, the respondents reported an optimistic and positive attitude toward telecommuting. The analysis showed clearly that supervisors' opinions of the performance of their employees did not diminish with the introduction of telecommuting.

Characteristics dealing with the workplace atmosphere (such as motivation, professional appearance, and distractions) were considered to be similar at both the regular workplace and the telecenter. Areas in which the center was perceived less positively than the regular workplace concerned the supervisor-employee relationship (such as communication, availability, professional interaction, and administrative burden) as well as security of information and property. However, mean ratings for the telecenter on these characteristics were all neutral or better, indicating that the disadvantage is relative, not absolute. These attitudes seem to be generic to telecommuting in general since they tended to be even less favorable for home-based telecommuting.

Nearly all of the managers (93%) indicated having a positive attitude toward telecommuting in general, and 82% rated their level of satisfaction with center-based telecommuting as high or very high. (However, a selection bias must be noted, as managers who were dissatisfied with telecommuting would be less likely to have lasted long enough to complete an after survey. As indicated in Section 5.3, supervisor-related concerns were cited by 5 of the 20 employees from whom reasons for quitting could be obtained as important reasons for quitting telecommuting). Six potential advantages were viewed by managers to be at least moderately significant following the introduction of center-based telecommuting: improved employee retention, improved ability to recruit employees, increased productivity, compliance with environmental regulation, improved employee relations, and (marginally) reduced absenteeism. However, from 11% to 21% of the managers reported "no opinion" on the four following potential advantages of telecommuting: improved ability to recruit employees, reduced health costs, compliance with environmental regulations, and improved disaster response capability. This suggests the need to raise awareness of the potential benefits of telecommuting in these areas.

It is an important result that the perceived advantages of telecommuting are those for which the benefit is difficult to quantify (customer service and productivity), while telecommuting is not perceived to offer advantages on "hard" money items such as office space and parking costs. This will continue to make center-based telecommuting difficult to justify in purely economic terms. Indeed, while 39% of the respondents indicated that the organization was likely to (continue to) offer center-based telecommuting, an equal proportion cited reduced costs, the ability to quantify the benefits, and increased manager acceptance as factors that needed to change before the organization would be likely to offer center-based telecommuting.

About half of the managers expected that more of the organization's workforce would be telecommuting from a center in the future. However, from one-sixth to one-third of the organizations themselves did not have official opinions on various potential advantages of telecommuting according to the respondents. When opinions by the management levels above the supervisors were expressed, they tended to be less positive than those of the supervisors. Indeed, it appears that some managers are supporting telecommuting for their staff in the face of actively negative attitudes on the part of upper management. This suggests the need for upper-level management to have increased exposure to the benefits of telecommuting.

Although the employees performed well at the telecenter or even better than they did at the regular workplace in some aspects, managers still preferred telecommuting to be a part-time alternative for their employees. Very few managers expected their employees to be telecommuting from the center full-time. The managers' average ideal distribution of work time for their employees included nearly 64% at the regular workplace and 29% for center-based telecommuting. The current and the expected future telecommuting frequencies of 30% (which is equivalent to 1.5 days per week) are consistent with the managers' ideal work time distribution. However, in the managers' perception, the appropriate telecommuting frequency for their employees was more constrained by job suitability (32% of work time on average) than by the managers' willingness (37%). In any case, the managers still feel that the regular workplace is the primary work location, to be used three or more days out of the work week.

Home-based telecommuting was not perceived as positively as center-based telecommuting with respect to job suitability and permitted frequency, although the self-selection bias of the sample must be taken into account in interpreting this result. The managers were willing for the employees to telecommute nearly three times as often from the center as from home. Also, some mixture of center and home-based telecommuting was considered ideal by nearly one-third of the managers.

This expectation of part-time telecommuting may act to inhibit the adoption of telecommuting centers. If employees are only using the center one or two days per week, there may be little opportunity for their space at the regular workplace to be used for other purposes. If an organization must continue to offer the same amount of space at the regular workplace as before, plus pay rent on space at the telecenter, other telecommuting advantages will have to be that much stronger to compensate for the added cost.

7.1.2.3 Employee-Manager Comparison

The comparison of similar questions from the employee and manager surveys is constrained by the limited sample sizes in the interim data set. The data compared in this section are overall group means rather than matched employee-manager results. Consequently, the differences in means may be due to the mismatch between groups rather than to the differences between employees and their particular managers.

Not surprisingly, the preferred amount of telecommuting differs between employees and managers. On average, employees would ideally work less of their time at the regular workplace (44.6%) and more at the telecommuting center (41.5%) than managers would prefer them to (63% and 29% at the regular workplace and telecenter, respectively). Working at the main office and the telecenter proved to be the most preferred combination of workplaces for both groups. Importantly, employees believed that the nature of the job allowed for about 40% telecommuting from a center, while managers said only 32% of time was suitable, on average. Although some of the telecommuting frequency averages are similar for employees and managers, the managers select lower telecommuting amounts when there are substantial differences between the two.

Responses for similar job performance and satisfaction questions and the results of analyses of variance for similar work environment characteristics questions were mostly similar for both study groups. Surprisingly, on some job performance factors, employees rated themselves lower than the managers did. The three job satisfaction factors that had sizeable differences were resource

availability, client demands, and supervisor appreciation. Employees were less satisfied with the first two job factors and more satisfied on the last factor than the managers were.

7.1.3 Analysis of Telecommuting Patterns

Chapter 4 describes a study of the telecommuting patterns of center-based telecommuters, taken primarily from information compiled from the attendance logs at the telecenters. This analysis identifies patterns of telecommuting duration and frequency, and increases our understanding of telecommuter working behavior on telecommuting days. The study analyzes telecommuting patterns both at the aggregate (site) level and the disaggregate (individual) level. Both analyses are consistent with each other and complementary.

For most of the telecenters, a usage rate of between 10% and 20% was maintained. Though the usage rates fluctuated, overall growth is apparent. As of the June 30, 1995 cutoff date for this interim report, the RABO telecenters had been open an average of 9.1 months, with a minimum of 2.5 months and a maximum of a little more than 20 months. The two non-RABO telecenters have been operating for much longer, an average of 3.1 years.

At RABO sites, the average telecommuting frequency was 25%, or 1¼ days per week. More than half of the telecommuters telecommuted less than one day per week on average, and 22% telecommuted 1 to 2 days per week. The non-RABO telecommuters telecommuted less frequently than those who were at RABO sites; the average was 17.2%, with about 75% of non-RABO telecenter users telecommuting less than one day per week.

Attrition at the telecenters was relatively high, with 50% of all telecommuters quitting within the first nine months. Although little comparative data are available, this appears to be higher than for home-based programs. Reasons for quitting telecommuting are analyzed in Chapter 5. But in any case, the frequency and distribution of telecommuting are crucial factors to consider in any forecast of levels and impacts of telecommuting. Of the 92 RABO participants who telecommuted often enough to analyze, half telecommuted for at least 8 months, and more than 25% telecommuted for at least one year. At non-RABO sites, 50% of the 130 telecommuters analyzed telecommuted for at least 9 months, and 25% telecommuted for at least 2 years. There is no significant difference in telecommuting duration between RABO and non-RABO sites.

A majority of telecommuters (53%) worked at the telecenters for at least 6 hours on average on their telecommuting days. The most common telecommuting pattern was to work entirely at the telecenter. Approximately 22% of the telecommuters at RABO sites telecommuted with this pattern on all of their telecommuting occasions, and an additional 23% did so at least 80% of the time. At least 34% usually worked at more than one work location, including 8% who always did. The second most common workplace combination was telecenter/other work location (i.e., other than home or the regular workplace). Contrary to expectation, center- and home-based telecommuting are not often combined on the same day; patterns involving these two locations occurred only 17% of the time at RABO sites.

Driving alone was the dominant transportation mode used by the telecommuters in commuting to the center. About 46% of the RABO telecommuters drove alone to the center on all of their telecommuting occasions. More than two-thirds drove alone to the center very frequently (more than 75% of their occasions).

7.1.4 Retention Analysis

Chapter 5 explored the attrition of telecommuters in the RABO Project. First, the characteristics of the respondents who quit were compared with the characteristics of those who stayed with the program. Second, the motivations of the quitters to leave the program were described. Third, the duration and frequency of telecommuting among both the stayers and quitters was investigated. In order to conduct this analysis, a particular sample of project participants was identified.

The responses to the before-wave surveys were used to find differences between 22 stayers and 24 quitters. According to employment type, administrative workers were more likely to quit (5 of the 7) and sales workers were more likely to remain in the program (5 of the 6). Surprisingly, quitters spent more time working remotely (more suited for telecommuting) than stayers. However, this result may explain why quitters preferred to spend more time working from home (23.5%) than stayers did (12.2%). Although job performance and satisfaction did not differ significantly between the two groups, certain work environment characteristics were significantly different. Quitters were more likely to worry about distractions at the telecenter and to consider the need for essential equipment to be important. Unfortunately, the findings from the survey data cannot point to the motivation for quitting, especially since the survey was administered prior to the experience with telecenter use.

The exit interview captured the reasons for quitting. The most important reason given was that respondents changed position within the company or their assigned tasks changed (25%). Thus, external corporate downsizing and reorganization were the most likely causes of quitting. Other important reasons include the supervisor requiring or encouraging the respondent to quit (21%) and leaving the company (13%). The reason for quitting is unknown for four individuals (17%).

The attendance log data showed that telecommuting duration and frequency varied widely within each group. The quitters who actually used the telecenter at least twice (16 of the 24 quitters) telecommuted an average of 7.2 months before leaving the program. For comparison, the stayers had telecommuted for an average of 10.7 months at the time of the final data entry. Quitters with some telecenter experience generally telecommute less often than stayers (24% vs. 30%, or 1¼ vs. 1½ days per week). This difference is reflected in the distribution of telecommuting frequency, where 9 quitters (56%) telecommuted less than one day per week while 13 stayers (54%) telecommuted one day per week or more. Perhaps quitters did not telecommute often enough to make the changes to their work schedule worthwhile.

7.1.5 Travel Characteristics

In Chapter 6 the travel characteristics of the respondents were studied. Four main travel indicators, namely the number of trips, PMT (person-miles traveled), VMT (vehicle-miles traveled), and mode choice distributions, were studied. Two main sets of comparisons were made: the first between the control group of non-telecommuters and telecenter users on non-telecommuting days and the other between telecommuting and non-telecommuting days for telecenter users.

The control group was found to have significantly different travel characteristics than the telecommuting group, with the latter making fewer trips (4.3 compared to 5.9) but traveling larger

distances (90.9 average weekday PMT compared to 47.9 miles for the control group), on average. The differences in PMT and VMT could be attributed to differences in commute distances, and the difference in number of trips could be linked to the fact that telecenter users are left with a significantly smaller amount of time for discretionary activities in view of their long commutes to the regular workplace.

Since the non-telecommuter group is not as comparable to the telecenter users as would be desired, we focus on the comparison between telecommuting days and non-telecommuting days for telecenter users. Comparing telecommuting days and non-telecommuting days, one finds that while the average number of trips are almost the same, PMT and VMT values are significantly different, with the average weekday distance traveled by all modes decreasing by more than 74% on telecommuting days. Also, telecommuters on telecommuting days showed a reduction of nearly 52% in PMT when compared with the controls. Thus, these results point to considerable savings in travel on telecommuting days, not just against telecommuters' own extreme baseline, but against a more normal employee's travel behavior on an average workday.

Next, the distribution of trips with respect to time of day and purpose was explored. Significant differences were found between the temporal distributions of trips on telecommuting days and non-telecommuting days. Comparisons of telecommuters' non-telecommuting days with the control group, however, showed no significant differences. The distributions exhibited an interesting ordering of trip start times with telecenter users on non-telecommuting days starting the earliest, followed by the control group, and then telecenter users on telecommuting days (because of their significantly shorter commute distances). The temporal distribution for telecenter users on telecommuting days also showed a significant lunch time peak. Comparisons of the distribution of trip purposes indicated that the distributions for the control group and the telecenter users on non-telecommuting days were statistically different while those on telecommuting and non-telecommuting days were even more significantly different. The differences arose due to (1) a significantly higher number of *return home* and *eat meal* trips, (2) a higher proportion of *shopping* and *social/recreation trips*, and (3) an absence of *change mode* trips on telecommuting days. This last factor corroborates the conclusions drawn by comparing the travel indicators for non-telecommuters and telecenter users on telecommuting days (see Section 6.2.3) and the discussion on mode choice (Section 6.3), and implies that a smaller variety of modes are used on telecommuting days, with most of the trips made while driving alone.

To study the trip chaining behavior of the respondents, the average number of links in a home-home chain were compared for telecommuting and non-telecommuting days. The comparison revealed a significantly higher number of links on non-telecommuting days. This could be attributed to the long commute distances on such days. As the average number of trips is almost the same for the two sets of days, one could hypothesize that on telecommuting days the respondents make a larger number of home-to-home cycles involving a smaller number of links.

A comparison of commute and non-commute travel on telecommuting and non-telecommuting days showed that there is a drastic reduction in the commute PMT (by 66.9 miles) and VMT (by 41.0 miles) on telecommuting days. Also, the non-commute PMT decreases almost a mile on telecommuting days. However, non-commute VMT actually increases by two and a half miles on telecommuting days. Therefore, there is a decrease in the non-vehicular, non-commute travel occurring on telecommuting days.

Though the average numbers of trips on both non-telecommuting days and telecommuting days are almost equal, the distribution of trips between commute and non-commute purposes differs. On telecommuting days, there is a statistically significant increase of 0.5 commute trips. Also, there is a decrease of 0.6 non-commute trips on telecommuting days, though the difference is not statistically significant.

Next, the commute mode choice distributions for the study groups were analyzed. The travel diary and attitudinal survey data show that there is a substantial difference between the commute mode choices of telecenter users on telecommuting days and non-telecommuting days. The percentage of drive-alone trips is substantially higher and the percentages of transit and rideshare trips are substantially lower on telecommuting than on non-telecommuting days. Also, a before and after comparison of the commute mode splits reported in the attitudinal survey revealed that telecommuting has not affected the commute mode choices of the respondents on non-telecommuting days.

Finally, to obtain a better understanding of the overall process, the aggregate values of the travel indicators were studied. This was done by weighting the travel indicators by the corresponding telecommuting frequency. The aggregate figures indicate that at current frequencies of telecommuting (18.2% on average, or approximately once in five days), the telecenter users travel significantly larger distances: a composite weekday average of 73.1 miles compared to 49.1 miles for the control group. Two factors contribute to the difference in aggregate travel between telecenter users and the controls: (1) the non-telecommuting day PMT (VMT) for the telecenter users is considerably larger than that for the controls, and (2) the level of telecommuting is not high enough to counter this difference. But, while the telecenter users still travel more than the control group members, they would have had an average PMT of 90.9 miles had they not been telecommuting. Telecommuting from a center reduced their total weekday travel by nearly 19%. Two factors contribute to the difference in aggregate travel between telecenter users and control group members: (1) the PMT (and VMT) on non-telecommuting days for the telecenter users is considerably larger than that for control group members, and (2) the level of telecommuting is not high enough to counter this difference.

It could be hypothesized that commute distance is an important factor in the preference to telecommute and that a self-selection bias occurred in the selection of the study groups, with respondents who lived farther away opting to be in the telecommuting group. However, the possibility that commute distance might have been a criterion *used by the employers* in selecting respondents for the telecommuting group (thus generating an unintentional bias) and the fact that at least three-quarters of the non-telecommuting group expressed a desire to telecommute suggest that commute length is not the only motivation in a preference to telecommute. If telecommuting is primarily attractive to long-distance commuters, considerable per capita reductions in travel will result though only in a particular market segment. Conversely, if the appeal is more universal, the reductions in travel per capita are not likely to be as high as in the sample but would apply to a larger segment of the workforce.

7.2 Possible Future Analyses

As an interim evaluation report, this document imparts the results of the analysis of only a portion of the data to be collected under the RABO project evaluation. The additional data that has been collected since June 30, 1995, along with the data collected previously, will be analyzed

for the final report and in additional studies as funding permits. The combined data set will allow both the confirmation (or revision) of the findings presented in this report as well as the ability to conduct new analyses. The high-quality and multi-faceted data set provided by this study is expected to yield new insights into telecommuting for some time to come.

All analyses described in this report could benefit from additional data. Comparisons of before and after changes to employee and manager characteristics may become significant given a sufficient sample size. Additional months of attendance log data can be used to look into the patterns relating to the frequency and duration of telecenter use and the aggregate utilization of sites that have increased operational longevity and marketing experience. One can also learn more about the reasons for quitting from the additional participants who quit. More completed travel diaries can be used to better pinpoint the changes to travel behavior. In fact, the evaluation of the full data set may reverse some conclusions based on the interim analysis if a significant amount of different data is collected.

A recent addition to the evaluation was the development of a videoconferencing sign-in log (Section 2.4.2). This survey instrument was put into use after June 30, 1995, so no results are yet available for the interim report. However, analysis of the logs will be able to show the frequency of videoconference use and will qualitatively indicate possible travel savings based on whether the videoconference substituted for a lengthy trip to an in-person meeting.

Besides replication of the analyses reported here with a larger data set, new analyses could also be conducted. Some potential analyses of interest are described below and are classified by the survey instrument on which they are based.

7.2.1 Attitudinal Survey and Sign-in Log Data

Additional studies of the attitudes of employees and managers toward telecommuting are also possible. The three dimensions of the survey plan (before and after; employee and manager; and telecenter user, home-based telecommuter, and non-telecommuter) allow for a number of comparisons across groups. First, direct comparisons between the attitudes and characteristics of telecenter users and each control group would provide useful insights into the type of individual who wants to telecommute from a center as opposed to from home or not at all. Second, each employee could be matched with his or her manager to compare responses to telecommuting attitudes and work characteristics. Third, comparisons of before and after telecommuting can be performed as conducted in the evaluation reported here. For the last two comparisons, the control groups can be used to control for background changes in the workplace in order to isolate differences between employees and managers and between before and after telecommuting.

Importantly, this data set provides for the modeling of telecommuting preference and choice. Although preference modeling has been performed using the interim before data (Stanek, 1995), further studies of both telecommuting preference and choice can be conducted using the full before and after data sets. These models can be used to identify key factors in the decision-making process and to predict the future amount of telecommuting by the workforce. In particular, the after data can be used to build binary and multinomial models of choice and frequency. Furthermore, analyzing the before and after data together may offer a rare opportunity to calibrate a prospective expression of preference against the actually chosen telecommuting

frequency. In addition, all models mentioned above can be applied both to the employee's decision to telecommute and to the manager's decision to have the employee telecommute.

As a precursor to the telecommuting choice models, factor analysis is used to reduce the responses on the job satisfaction and workplace attitudinal questions to their underlying perceptual dimensions. Scores on these dimensions or factors are then used as explanatory variables in preference and choice models. The factor analysis procedure can also be used to compare perceptual structures between employees and managers as well as to detect changes in these structures after the start of telecommuting.

The sign-in logs provide data for developing, for the first time, models to predict telecommuting duration as a function of hypothesized explanatory variables from the attitudinal surveys. In addition, the attendance logs provide a supplementary source of telecommuting frequency data for choice models.

7.2.2 Travel Diary Data

The travel diaries provide a rich source of information about the transportation impacts of telecommuting. Perhaps most importantly, the data provide an opportunity to conduct an emissions analysis of telecommuting center use similar to the study by Henderson and Mokhtarian (1996) of the much smaller sample of telecenter users in the Puget Sound telecommuting project. One would expect the emissions analysis to show reductions in the pollutants most closely tied to VMT, particulate matter and nitrogen oxides, to be commensurate with the VMT reductions reported in Section 7.1.5. Since the number of trips did not change, if the number of cold and hot starts remains approximately the same, then there will be little change to carbon monoxide and hydrocarbon emissions. However, these pollutants also have a component that is a function of VMT, so some benefit to air quality for those components would be realized. On the other hand, if the reduced trip chaining observed to occur on telecommuting days means an increase in the number of cold starts, these pollutants would be adversely affected. Conducting a rigorous emissions analysis would be important to determining the net impact of these counteracting factors.

In an attempt to measure the effects of telecenter use on household travel, travel diaries were administered to all members of the telecenter user households who were sixteen years of age or older. Using this additional data, an analysis of travel at the household level can be performed to examine whether reductions in travel by the telecommuter are partially compensated for by increases in travel on the part of household members. Also, the emissions analysis would be more rigorous if all uses of a household vehicle were accounted for, thus allowing each particular trip to be more accurately classified as either a hot or cold start. Although household member data is generally less complete, it may be possible in the larger final data set to identify a subsample with complete data that is large enough to analyze.

The travel diary data also allow for a spatial analysis of the travel impacts of telecenter use. Such an analysis would analyze the extent to which new locations are visited after telecommuting and the spatial orientation of those locations relative to home, the telecenter, and the regular workplace (similar to the study by Saxena and Mokhtarian (1997) for home-based telecommuting). An interesting difference from the previous study is the introduction of the telecommuting center as a frequently-visited destination. This may lead to the identification of

new destinations near the center, which has implications for the local economic development impacts of telecenters.

7.3 Discussion of Findings

Overall, the interim experience with telecommuting centers has been positive, with some indicators that require continued monitoring. Employee reactions to center-based telecommuting have been favorable, and no adverse impacts on productivity and job satisfaction were measured. There may be a selection bias in these results as these data were obtained only for employees remaining in the program. However, reasons for leaving the program are discussed below. On average, telecenter users preferred to work from the regular workplace and the telecommuting center for approximately equal amounts. In particular, about 31% of the telecenter users also preferred to work at home for some part of the work week; however, according to current practice, home- and center-based telecommuting are seldom undertaken on the same day.

The transportation impacts of center-based telecommuting were complex. On the less desirable side, there was an increase in drive-alone trips and a decrease in trip chaining on telecommuting days. Most commuting to the telecenter took place by driving alone, despite efforts to locate centers sufficiently close to residential areas that walking and biking would be attractive commute modes. Interestingly, there was a small increase (of 0.5, significant at $\alpha = 0.02$) in the number of *commute* trips made on telecommuting days, apparently due to telecommuters making trips home for lunch and returning to the center in the afternoon. On the positive side, however, telecommuting did not adversely affect commute mode choices on non-telecommuting days. And most importantly, the number of person-miles traveled (PMT) decreased by an average of nearly 74% on telecommuting days, while the *total* number of trips made remained constant.

To place the PMT reduction in the proper perspective, it is important to realize two things. First, the reduction represents a comparison between travel on non-telecommuting weekdays and telecommuting weekdays for center-based telecommuters. Thus, the overall impact on travel will be a function of the frequency of telecommuting. When travel indicators on telecommuting and non-telecommuting days were weighted by the average frequency with which each type of day occurs, an average reduction of 31% in total weekday travel of telecenter users was found.

Second, the telecommuters in this sample lived farther from work, and hence had a much greater average non-telecommuting day PMT, than the non-telecommuting control group members (90.9 vs. 47.9 miles). Although on telecommuting days the telecommuters traveled less than the control group, in the aggregate (telecommuting and non-telecommuting days combined) they still traveled more. If, in the future, telecommuting continues to be adopted primarily by long-distance commuters, the per capita reductions in travel will be considerable, but this change will be achieved by a limited segment of the market. If, on the other hand, the adoption of telecommuting is more universal, the per capita reductions in travel will be smaller, albeit achieved by a wider segment of the market. In either case, the specific reductions measured in this study will not be representative of the impacts for the population as a whole.

On the organizational side, managers of telecenter users were generally supportive, with 93% having a positive attitude toward telecommuting in general, and 82% rating their level of satisfaction with center-based telecommuting as high or very high. (However, a selection bias must be noted since managers who were dissatisfied with telecommuting would be less likely to

remain in the program long enough to complete an after survey). Opinions of upper management tended to be more neutral according to the immediate supervisors of telecommuters. The perceived advantages of telecommuting were those for which the benefit is difficult to quantify (customer service and productivity), while telecommuting is not perceived to offer advantages on "hard" money items, such as office space and parking costs. This will continue to make center-based telecommuting difficult to justify in purely economic terms. Indeed, while 39% of the manager respondents indicated that the organization was likely to offer center-based telecommuting to its staff, an equal proportion cited lowering the cost, being able to quantify the benefits, and increased manager acceptance as factors that needed to change before the organization would be likely to offer center-based telecommuting.

Managers continued to view the regular workplace as the primary work location for their employees, to be used for at least three days per week on average. This expectation of part-time telecommuting may act to inhibit the adoption of the center-based form, as there will be little opportunity for the organization to re-use the telecommuter's space in the regular workplace.

Average site occupancies ranged between 10 and 20% of available workspace days, with a generally upward trend. The 10 RABO sites with sufficient attendance log data to be included in this report had been open a minimum of 2.5 months and a maximum of 20 months (average 9.1 months) through June 1995. It will be important to examine how site occupancy changes with an additional year of operation (July 1995 to June 1996). For those who used the centers at least twice, telecommuting frequencies averaged 25% (1¼ days per week) at RABO sites and 17% at non-RABO sites.

Attrition at the telecenters was relatively high: 50% of all telecommuters quit within the first nine months. Although little comparative data are available, this appears to be higher than home-based programs. Results of exit interviews, conducted with the 24 participants who quit after this program began and who could be reached, suggest that primary reasons for quitting relate to changes in job circumstances (25%) and to supervisor's desires (21%) rather than to employee dissatisfaction with telecommuting. Nevertheless, the frequency and duration of telecommuting are crucial factors to consider in any forecast of levels and impacts of telecommuting.

In summary, while transportation and other impacts are unequivocally positive on net for those who telecommute on the days they are telecommuting and for the duration of their telecommuting experience, concerns remain about high attrition among telecenter users and about the perceived cost-effectiveness of center-based telecommuting to organizations.

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APPENDIX A

SELECTED ATTITUDINAL SURVEY TABULATIONS FOR AFTER EMPLOYEE DATA

APPENDIX A: SELECTED ATTITUDINAL SURVEY TABULATIONS FOR AFTER EMPLOYEE DATA

In this appendix, the results of statistical tests of telecenter users, which are described in Chapter 3, are tabulated. Except where noted, the sample is composed of the 39 respondents to the after telecenter user survey. Significantly differing means at a level of significance of 0.10 are marked in boldface type. Tables A-1 and A-2 report the mean response from a 5-point scale that runs from strongly disagree (1) to strongly agree (5). Table A-4 reports the mean response from a 4-point scale that runs from not at all important (1) to extremely important (4). Figure A-1 presents charts of the mean responses to the work environment characteristics listed in Table A-2.

Table A-1: Employee Job Performance and Satisfaction Questions

1. Respondent's Opinion (N=39)	Mean	Std. Dev.
a. Amount of work	4.26	0.59
b. Quality of work	4.44	0.55
c. Ability to meet deadlines	4.18	0.79
d. Overall productivity	4.36	0.63
2. Opinion of Supervisor's Rating (N=37)		
a. Amount of work	4.30	0.78
b. Quality of work	4.32	0.78
c. Ability to meet deadlines	4.16	0.83
d. Overall productivity	4.24	0.80
3. Satisfaction Components (N=39)		
a. Supervisor communication[1, 3]	4.16	1.03
b. Promotion opportunity[1]	3.61	1.15
c. No lack of resources[3]	3.54	1.21
d. Work team is effective	3.85	0.84
e. Work well with supervisor[1]	4.08	0.94
f. Clients are not unreasonable[2, 3]	3.46	0.93

[1] N = 38 [2] N = 24

[3] Statements were negatively worded on the survey, but changed to a positive orientation for comparison with other responses.

Table A-1: Employee Job Performance and Satisfaction Questions (Continued)

3. Satisfaction Components (N=39)	Mean	Std. Dev.
g. Overall satisfaction	4.05	0.83
h. Get a sense of accomplishment	4.03	0.87
i. Supervisor appreciation[1, 2]	4.05	1.18
j. Get along well with co-workers[2]	4.49	0.88
k. Confident in abilities	4.51	0.56
l. Unlikely to look for a new job[2]	3.82	1.07
m. Work well with those supervised[1]	3.93	0.96
n. Job is not tedious and boring[2]	4.33	0.62

[1] N = 15

[2] Statements were negatively worded on the survey, but changed to a positive orientation for comparison with other responses.

Table A-2: Employee Work Environment Questions (N=39)

Question	Location	Mean	Std. Dev.
1. Easy to be motivated	Reg. Workplace	4.03	0.84
	Telecenter	4.41	0.55
	Home	3.21	1.20
2. Stressful to work	Reg. Workplace	2.82	1.25
	Telecenter	1.67	0.62
	Home	2.59	1.02
3. Supervisor uncomfortable	Reg. Workplace[1]	1.61	0.89
	Telecenter[1]	2.08	0.97
	Home[1]	2.76	1.26
4. Professional appearance	Reg. Workplace	4.10	0.72
	Telecenter	4.08	0.81
	Home	2.74	1.07

[1] N = 38

Table A-2: Employee Work Environment Questions (Continued)

Question	Location	Mean	Std. Dev.
5. Distractions from others	Reg. Workplace	3.72	1.15
	Telecenter	2.21	1.06
	Home	2.72	1.28
6. No free time	Reg. Workplace	3.87	1.06
	Telecenter	2.23	1.16
	Home[1]	2.03	0.96
7. Overeat or indulge	Reg. Workplace	2.10	0.79
	Telecenter	2.00	0.56
	Home	2.77	1.16
8. Social interaction	Reg. Workplace	3.97	0.84
	Telecenter	3.08	1.04
	Home	2.36	0.96
9. Relative independence	Reg. Workplace	3.31	1.13
	Telecenter	4.13	0.83
	Home	4.08	0.81
10. Convenient to run errands	Reg. Workplace	2.87	1.22
	Telecenter	3.79	0.86
	Home	3.82	1.00
11. Not enough space	Reg. Workplace	2.05	0.89
	Telecenter	2.03	0.74
	Home	2.79	1.40
12. Good for the environment	Reg. Workplace	2.10	0.94
	Telecenter	4.21	0.73
	Home	4.46	0.55
13. Not visible to management	Reg. Workplace[1]	1.79	0.78
	Telecenter[1]	2.87	1.09
	Home[1]	3.24	1.15

[1] N = 38

Table A-2: Employee Work Environment Questions (Continued)

Question	Location	Mean	Std. Dev.
14. Not have needed equipment	Reg. Workplace	1.77	0.58
	Telecenter	2.00	0.73
	Home	3.21	1.28
15. Keep home and work separate	Reg. Workplace	1.72	0.72
	Telecenter	1.64	0.63
	Home	3.10	1.39
16. Control over environment	Reg. Workplace	2.54	1.21
	Telecenter	3.08	1.20
	Home	3.77	1.04
17. Cost too much	Reg. Workplace	3.31	1.24
	Telecenter	1.97	0.81
	Home	2.03	1.04
18. Commute is a hassle	Reg. Workplace	4.28	0.94
	Telecenter	1.69	0.83
	Home	1.51	0.79
19. Work while sick or disabled	Reg. Workplace[1]	2.08	1.00
	Telecenter[1]	3.26	1.31
	Home	4.10	1.14
20. Scheduling freedom	Reg. Workplace	3.23	1.16
	Telecenter	3.77	1.06
	Home	4.03	0.93
21. Can handle dependent care	Reg. Workplace[2]	2.52	1.25
	Telecenter[2]	3.71	1.06
	Home[3]	3.95	0.84
22. Work judged by results	Reg. Workplace	3.77	1.13
	Telecenter	3.79	1.15
	Home	3.72	1.15

[1] N = 38 [2] N = 21 [3] N = 22

Table A-2: Employee Work Environment Questions (Continued)

Question	Location	Mean	Std. Dev.
23. Household conflicts	Reg. Workplace[1]	2.16	1.27
	Telecenter[1]	1.65	0.66
	Home[1]	2.74	1.37
24. Save me money	Reg. Workplace	1.74	0.75
	Telecenter	4.15	1.04
	Home	4.23	0.99
25. Requires self-discipline	Reg. Workplace	2.13	0.98
	Telecenter	2.23	1.04
	Home	3.28	1.39
26. No professional interaction	Reg. Workplace	2.00	1.03
	Telecenter	2.69	0.95
	Home	3.44	1.05
27. Dress the way I like	Reg. Workplace[2]	2.73	1.22
	Telecenter[2]	3.92	0.83
	Home[2]	4.38	0.72
28. Balance responsibilities	Reg. Workplace[2]	2.89	1.20
	Telecenter[2]	3.95	0.78
	Home[2]	3.62	1.09
29. Supervisor communication	Reg. Workplace[2]	1.83	0.88
	Telecenter[2]	1.94	0.92
	Home[3]	2.31	1.14
30. Work effectively	Reg. Workplace[2]	4.16	0.80
	Telecenter[2]	4.51	0.51
	Home[2]	3.76	1.09

[1] N = 31 [2] N = 37 [3] N = 36

Table A-3: Work Environment Characteristics - ANOVA Results (P-values)[1]

Question	Workplace Effect	Question	Workplace Effect
1. Easy to be motivated	**.000**	16. Control over environment	**.000**
2. Stressful to work	**.000**	17. Cost too much	**.000**
3. Supervisor uncomfortable[2]	**.000**	18. Commute is a hassle	**.000**
4. Professional appearance	**.000**	19. Work while sick or disabled[3]	**.000**
5. Distractions from others	**.000**	20. Scheduling freedom	**.004**
6. No free time	**.000**	21. Can handle dependent care[4]	**.000**
7. Overeat or indulge	**.000**	22. Work judged by results	.955
8. Social interaction	**.000**	23. Household conflicts[5]	**.001**
9. Relative independence	**.000**	24. Save me money	**.000**
10. Convenient to run errands	**.000**	25. Requires self-discipline	**.000**
11. Not enough space	**.002**	26. No professional interaction	**.000**
12. Good for the environment	**.000**	27. Dress the way I like[6]	**.000**
13. Not visible to management[2]	**.000**	28. Balance responsibilities[6]	**.000**
14. Not have needed equipment	**.000**	29. Supervisor communication[7]	.111
15. Keep home & work separate	**.000**	30. Work effectively[6]	**.000**

[1] The sample size (N) is 117, or three times the number of respondents (39) because each question is asked once for each of the three workplaces.
[2] N = 114 (3 missing cases)
[3] N = 115 (2 missing cases)
[4] N = 64 (2 missing and 51 not applicable cases)
[5] N = 93 (24 not applicable cases)
[6] N = 111 (6 missing cases)
[7] N = 108 (9 missing cases)

Table A-4: Employee Work Characteristic Importance Rating (N=27)

Question	Mean	Std. Dev.
1. Easy to be motivated	3.41	0.80
2. Stressful to work	3.15	0.77
3. Supervisor uncomfortable	3.67	0.48
4. Professional appearance	2.74	1.02

Table A-4: Employee Work Characteristic Importance Rating (Continued)

Question	Mean	Std. Dev.
5. Distractions from others	3.07	0.73
6. No free time	3.52	0.70
7. Overeat or indulge	2.85	1.13
8. Social interaction	2.81	0.79
9. Relative independence	3.44	0.51
10. Convenient to run errands	2.52	0.94
11. Not enough space	3.37	0.56
12. Good for the environment	3.26	0.86
13. Not visible to management	2.41	0.97
14. Not have needed equipment	3.74	0.53
15. Keep home and work separate	3.26	0.90
16. Control over environment	3.37	0.69
17. Cost too much[1]	3.04	0.87
18. Commute is a hassle	3.59	0.75
19. Work while sick or disabled	2.56	0.93
20. Scheduling freedom	3.26	0.76
21. Can handle dependent care	2.37	1.31
22. Work judged by results	3.74	0.53
23. Household conflicts	3.07	0.96
24. Save me money	3.30	0.87
25. Requires self-discipline	3.52	0.58
26. No professional interaction	3.11	0.70
27. Dress the way I like	2.89	0.80
28. Balance responsibilities	3.19	0.83
29. Supervisor communication	3.56	0.70
30. Work effectively	3.85	0.36

[1] N = 26

Figure A-1: Work Environment Characteristics Charts

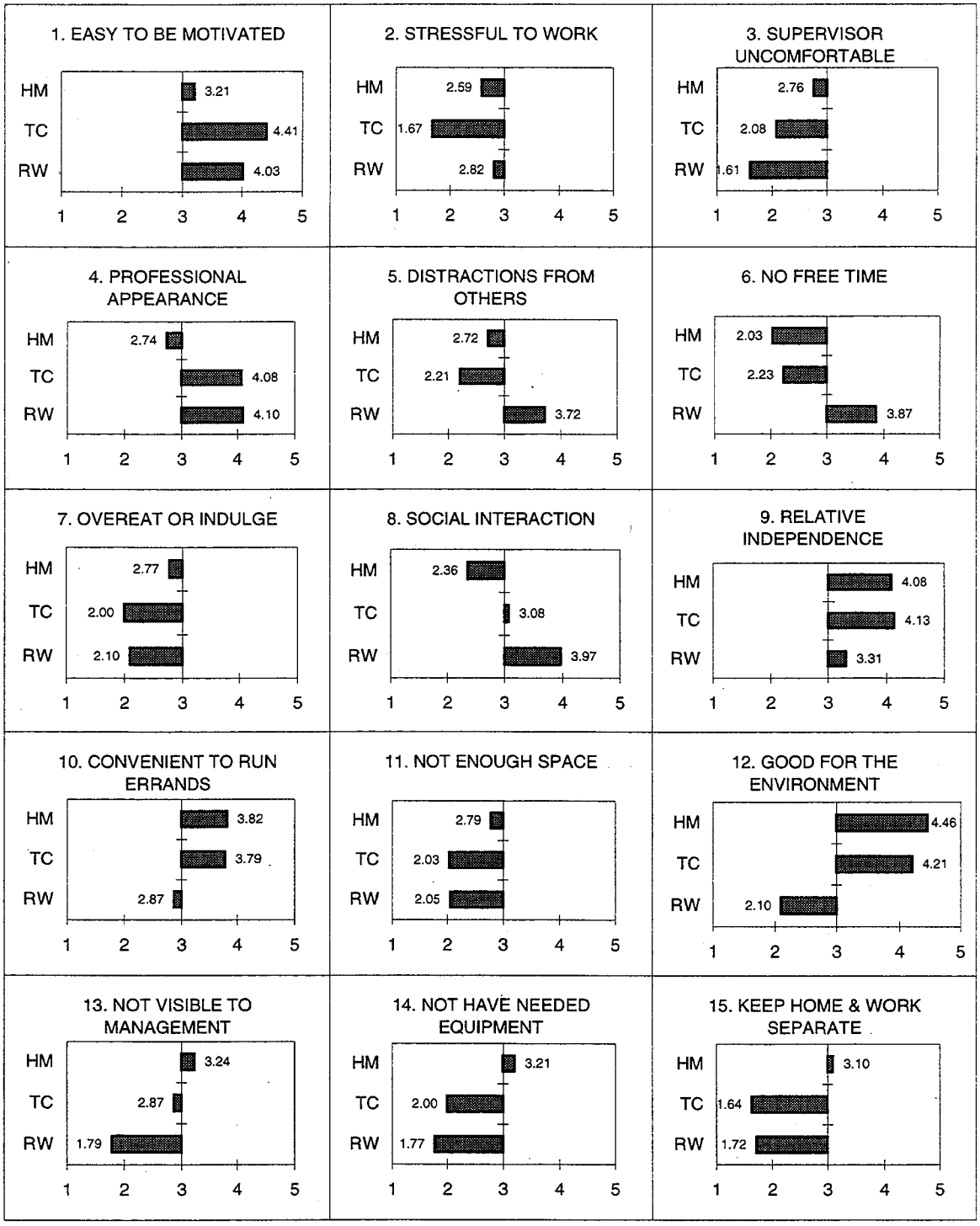
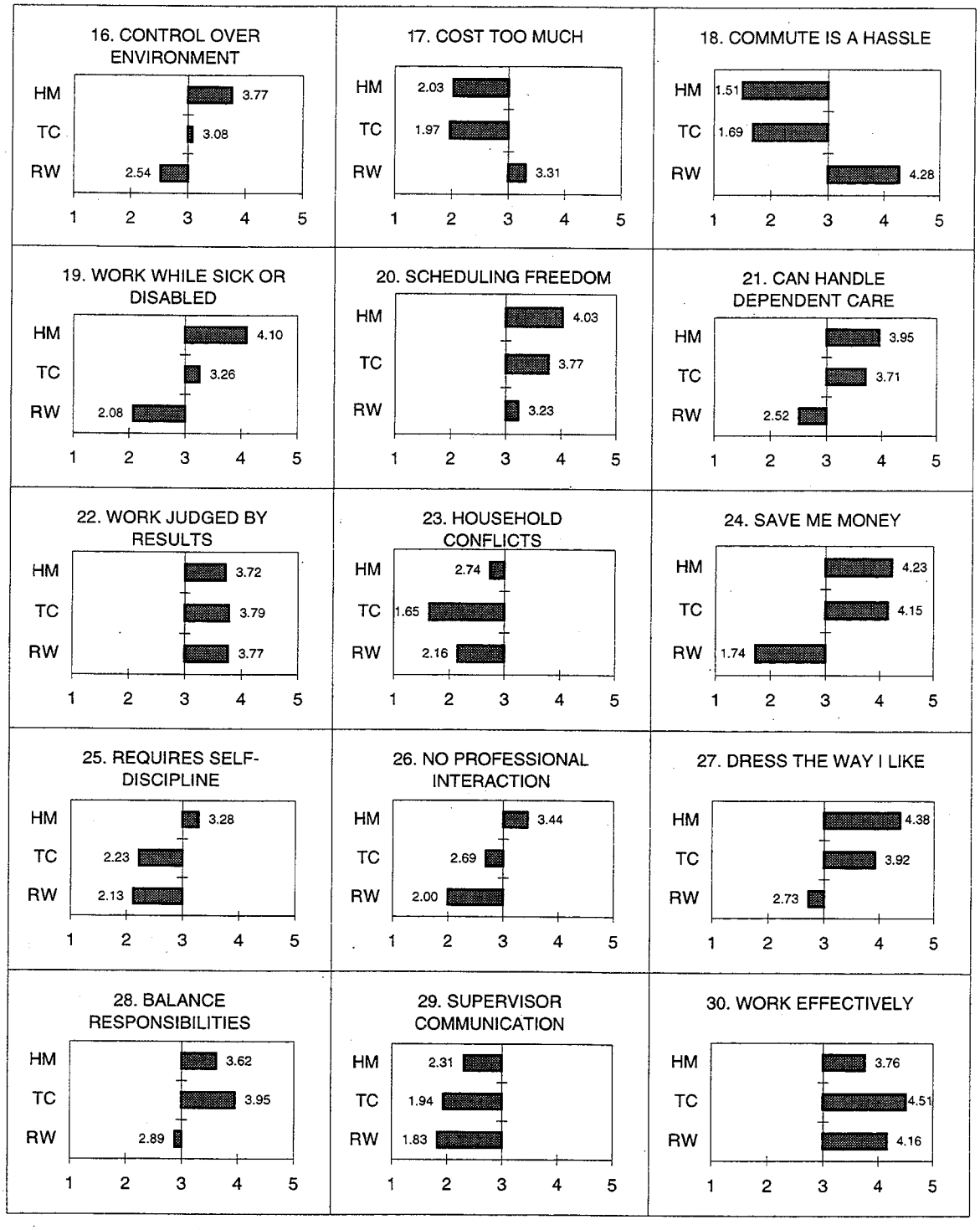


Figure A-1: Work Environment Characteristics Charts (Continued)



APPENDIX B

STATISTICAL TEST RESULTS FOR BEFORE/AFTER COMPARISONS OF EMPLOYEE DATA

APPENDIX B: STATISTICAL TEST RESULTS FOR BEFORE/AFTER COMPARISONS OF EMPLOYEE DATA

This appendix also tabulates the results of statistical tests of telecenter users, which are described in Chapter 3. Unlike Appendix A, the sample are those who responded to both the before and after versions of the telecenter user survey: the sample size is 27, except where noted. Significantly differing means at a level of significance of 0.10 are marked in boldface type. The calculation for telecommuting frequency (in terms of percent of days) given in Table B-1 is described in Table 3-10. Tables B-2 and B-3 report the mean response from a 5-point scale that runs from strongly disagree (1) to strongly agree (5).

Table B-1: Relative Telecommuting Frequency Means (N = 26)

Question	Before	After	t-statistic	p-value
Job suitability from a center	46.85	47.50	0.14	0.891
Job suitability from home	25.27	29.73	0.80	0.433
Manager support from a center[1]	43.16	45.44	0.40	0.693
Manager support from home[1]	**17.40**	**30.56**	**2.10**	**0.047**
Choice from a center	**21.58**	**37.65**	**2.47**	**0.021**
Choice from home[1]	6.16	10.16	1.03	0.312
Preference from a center	59.19	58.08	-0.29	0.773
Preference from home[2]	14.00	24.83	1.54	0.139
Expected from a center	**49.96**	**36.77**	**-2.66**	**0.013**
Expected from home[1]	10.08	10.28	0.05	0.964

[1] N = 25 [2] N = 23

Table B-2: Job Performance and Satisfaction Means

1. Respondent's Opinion (N = 27)	Before	After	t-statistic	p-value
a. Amount of work	4.15	4.33	-1.15	0.259
b. Quality of work	4.30	4.44	-1.16	0.256
c. Ability to meet deadlines	4.30	4.30	0.00	1.000
d. Overall productivity	4.19	4.37	-1.41	0.170
2. Supervisor's Opinion (N = 25)	Before	After	t-statistic	p-value
a. Amount of work	4.15	4.24	-0.21	0.832
b. Quality of work	4.35	4.24	0.89	0.382
c. Ability to meet deadlines	**4.42**	**4.16**	**1.99**	**0.058**
d. Overall productivity	4.23	4.12	0.85	0.405
3. Satisfaction Components (N=27)	Before	After	t-statistic	p-value
a. Supervisor communication[1, 4]	4.15	4.00	-0.74	0.467
b. Promotion opportunity[1]	3.78	3.54	0.91	0.372
c. No lack of resources[4]	3.85	3.44	-1.58	0.126
d. Work team is effective	4.04	3.89	0.89	0.381
e. Work well with supervisor[1]	4.00	3.96	0.37	0.713
f. Clients are not unreasonable[2, 4]	3.68	3.71	0.56	0.582
g. Overall satisfaction	4.04	3.93	0.65	0.523
h. Get a sense of accomplishment	4.15	3.85	1.44	0.161
i. Supervisor appreciation[1, 4]	4.26	3.88	-1.62	0.118
j. Get along well with co-workers[4]	4.70	4.59	-0.72	0.477
k. Confident in abilities	4.52	4.44	0.57	0.574
l. Unlikely to look for a new job[4]	3.37	3.67	1.07	0.294
m. Work well with those supervised[3]	4.11	3.89	0.59	0.587
n. Job is not tedious and boring[4]	4.07	4.26	1.55	0.134

[1] N = 26 [2] N = 15 [3] N = 5

[4] Statements were negatively worded on the survey, but changed to a positive orientation for comparison with other responses.

Table B-3: Work Environment Characteristic Means

Question	Location	Before	After	t-statistic	p-value
1. Easy to be motivated	Reg. Workplace	3.70	4.07	-1.51	0.143
	Telecenter	4.22	4.44	-1.10	0.282
	Home	2.93	3.07	-0.53	0.602
2. Stressful to work	Reg. Workplace	2.70	2.93	-0.59	0.558
	Telecenter	1.81	1.63	0.82	0.421
	Home	2.78	2.70	0.30	0.769
3. Supervisor uncomfort-able	Reg. Workplace[1]	1.89	1.65	0.82	0.422
	Telecenter[1]	2.30	2.08	0.64	0.526
	Home[1]	2.93	2.73	0.56	0.579
4. Professional appearance	Reg. Workplace	4.19	4.07	0.77	0.449
	Telecenter	3.93	4.00	-0.37	0.713
	Home	2.70	2.78	-0.28	0.783
5. Distractions from others	Reg. Workplace	3.44	3.63	-0.64	0.525
	Telecenter	**1.81**	**2.37**	**-2.31**	**0.029**
	Home	2.85	2.74	0.50	0.621
6. No free time	Reg. Workplace	3.89	3.93	-0.13	0.896
	Telecenter	2.04	2.30	-0.98	0.336
	Home[1]	2.15	2.15	0	1.000
7. Overeat or indulge	Reg. Workplace	2.56	2.19	1.19	0.246
	Telecenter	2.11	2.00	0.52	0.611
	Home	3.07	2.70	1.22	0.232
8. Social interaction	Reg. Workplace	3.96	3.89	0.28	0.783
	Telecenter	3.41	3.22	0.71	0.485
	Home	2.48	2.37	0.41	0.683
9. Relative independence	Reg. Workplace	3.56	3.37	0.68	0.503
	Telecenter	4.19	4.019	0	1.000
	Home	4.00	4.15	-0.85	0.404

[1] N = 26

Table B-3: Work Environment Characteristic Means (Continued)

Question	Location	Before	After	t-statistic	p-value
10. Convenient to run errands	Reg. Workplace	3.30	3.04	0.84	0.410
	Telecenter	3.70	3.89	-1.04	0.306
	Home	3.56	3.81	-1.66	0.110
11. Not enough space	Reg. Workplace	2.37	2.00	1.21	0.239
	Telecenter	2.26	1.93	1.43	0.164
	Home	2.89	2.96	-0.21	0.834
12. Good for the environment	Reg. Workplace[1]	1.85	2.04	-1.10	0.284
	Telecenter	4.44	4.33	0.83	0.416
	Home	4.52	4.52	0	1.000
13. Not visible to management	Reg. Workplace[1]	2.07	1.88	0.89	0.381
	Telecenter[1]	2.67	2.65	0	1.000
	Home[1]	3.04	3.04	0	1.000
14. Not have needed equipment	Reg. Workplace	1.70	1.81	-0.77	0.449
	Telecenter	1.78	1.93	-1.07	0.294
	Home	3.19	3.33	-0.49	0.626
15. Keep home and work separate	Reg. Workplace	1.81	1.81	0	1.000
	Telecenter	1.78	1.70	0.63	0.537
	Home	3.04	3.04	0	1.000
16. Control over environment	Reg. Workplace	2.37	2.74	-1.55	0.134
	Telecenter	3.30	3.33	-0.19	0.852
	Home	**4.15**	**3.67**	**1.72**	**0.097**
17. Cost too much	Reg. Workplace	3.33	3.41	-0.23	0.816
	Telecenter	1.81	1.89	-0.40	0.691
	Home	2.26	2.19	0.24	0.811
18. Commute is a hassle	Reg. Workplace	4.41	4.26	0.78	0.443
	Telecenter	1.56	1.67	-0.90	0.376
	Home	1.56	1.63	-1.43	0.166

[1] N = 26

Table B-3: Work Environment Characteristic Means (Continued)

Question	Location	Before	After	t-statistic	p-value
19. Work while sick or disabled	Reg. Workplace[1]	2.00	2.27	-0.79	0.435
	Telecenter[2]	3.33	3.42	-0.43	0.667
	Home	3.93	4.15	-0.73	0.471
20. Scheduling freedom	Reg. Workplace	3.52	3.33	0.71	0.485
	Telecenter	4.07	3.89	0.89	0.379
	Home	4.00	4.22	-1.06	0.297
21. Can handle dependent care	Reg. Workplace[3]	1.86	2.53	-1.25	0.240
	Telecenter[3]	3.71	3.87	-1.11	0.294
	Home[4]	4.00	3.94	-0.58	0.571
22. Work judged by results	Reg. Workplace[2]	3.62	3.52	0.53	0.603
	Telecenter[2]	3.58	3.59	-0.13	0.901
	Home[2]	3.58	3.48	0.25	0.805
23. Household conflicts	Reg. Workplace[5]	1.94	2.14	-0.77	0.453
	Telecenter[5]	2.00	1.77	0.64	0.530
	Home[5]	2.94	2.91	-0.14	0.892
24. Save me money	Reg. Workplace	2.00	1.89	0.62	0.542
	Telecenter	4.19	4.19	0	1.000
	Home	4.07	4.11	-0.14	0.890
25. Requires self-discipline	Reg. Workplace	2.15	2.15	0	1.000
	Telecenter	2.15	2.22	-0.27	0.791
	Home	3.37	3.22	0.49	0.626
26. No professional interaction	Reg. Workplace	2.07	2.19	-0.37	0.713
	Telecenter	2.59	2.56	0.13	0.898
	Home	3.30	3.33	-0.11	0.911

[1] N = 25 [2] N = 26 [3] N = 11 [4] N = 12 [5] N = 16

Table B-3: Work Environment Characteristic Means (Continued)

Question	Location	Before	After	t-statistic	p-value
27. Dress the way I like	Reg. Workplace[1]	2.96	2.60	1.11	0.276
	Telecenter[1]	4.19	3.96	1.14	0.265
	Home[1]	4.33	4.36	-0.21	0.832
28. Balance respon-sibilities	Reg. Workplace[1]	2.93	2.92	-0.15	0.880
	Telecenter[1]	3.85	3.92	-0.21	0.832
	Home[1]	3.33	3.60	-0.88	0.387
29. Supervisor communi-cation	Reg. Workplace[2]	2.00	1.96	0	1.000
	Telecenter[2]	2.04	2.00	0	1.000
	Home[2]	2.19	2.42	-0.95	0.354
30. Work effectively	Reg. Workplace[1]	4.15	4.24	-0.44	0.664
	Telecenter[1]	4.41	4.44	0	1.000
	Home[1]	3.59	3.80	-0.57	0.574

[1] N = 25 [2] N = 24

APPENDIX C

SELECTED ATTITUDINAL SURVEY TABULATIONS FOR MANAGER DATA

APPENDIX C: SELECTED SURVEY TABULATIONS FOR MANAGER DATA

The tables in this appendix tabulate the results of statistical tests of the managers of telecenter users, which are described in Chapter 3. Except where noted, the sample size is 28. Table C-1 reports the mean responses from a 5-point scale that runs from strongly disagree (1) to strongly agree (5). Figure C-1 presents charts of the mean responses to the work environment characteristics listed in Table C-1. Figure C-2 presents charts of the mean responses for questions with significant wave effects as shown in Table 3-18.

Table C-1: Supervisor Work Environment Questions

Question	Location	Mean	Std. Dev.
1. Easy to be motivated	Reg. Workplace	4.11	0.74
	Telecenter	4.29	0.53
	Home	3.64	1.03
2. Supervisor uncomfortable	Reg. Workplace	1.93	1.12
	Telecenter	2.00	0.90
	Home	2.71	1.27
3. Professional appearance	Reg. Workplace[1]	4.04	0.65
	Telecenter[1]	4.00	0.68
	Home[1]	2.59	0.93
4. Distractions from others	Reg. Workplace[1]	2.81	1.18
	Telecenter[1]	2.04	0.71
	Home[1]	3.22	1.01
5. Overeat or indulge	Reg. Workplace[1]	1.67	0.62
	Telecenter[1]	1.67	0.62
	Home[1]	1.78	0.70

[1] N = 27

Table C-1: Supervisor Work Environment Questions (Continued)

Question	Location	Mean	Std. Dev.
6. Relative independence	Reg. Workplace	3.79	0.96
	Telecenter	4.21	0.63
	Home	4.11	0.69
7. Good for the environment	Reg. Workplace	3.18	1.09
	Telecenter	3.86	0.71
	Home	3.57	0.88
8. Not visible to management	Reg. Workplace	1.82	0.67
	Telecenter	2.71	1.08
	Home	3.18	1.25
9. Not have needed equipment	Reg. Workplace	1.79	0.79
	Telecenter	2.21	0.79
	Home	3.43	1.10
10. Supervisor confident	Reg. Workplace	4.36	0.62
	Telecenter	4.32	0.61
	Home	3.82	0.94
11. Cost too much	Reg. Workplace[1]	1.78	0.58
	Telecenter[1]	2.00	0.62
	Home[1]	2.52	0.98
12. Work while sick or disabled	Reg. Workplace	3.86	0.80
	Telecenter	4.11	0.57
	Home	4.04	0.51
13. Scheduling freedom	Reg. Workplace	3.57	0.84
	Telecenter	3.93	0.72
	Home	3.93	0.72
14. Employee unavailable	Reg. Workplace	1.89	0.57
	Telecenter	2.46	0.92
	Home	2.79	1.07

[1] N = 27

Table C-1: Supervisor Work Environment Questions (Continued)

Question	Location	Mean	Std. Dev.
15. Work judged by results	Reg. Workplace	4.36	0.49
	Telecenter	4.46	0.51
	Home	4.36	0.62
16. No professional interaction	Reg. Workplace[1]	1.70	0.47
	Telecenter[1]	2.96	0.94
	Home[1]	3.37	1.04
17. Employee communication	Reg. Workplace	1.64	0.49
	Telecenter	2.21	0.79
	Home	2.46	0.84
18. Work effectively	Reg. Workplace	4.39	0.63
	Telecenter	4.32	0.61
	Home	3.89	0.83
19. Administrative burden	Reg. Workplace	1.71	0.53
	Telecenter	1.96	0.58
	Home	2.39	0.96
20. Security of information	Reg. Workplace	4.25	0.44
	Telecenter	3.93	0.66
	Home	3.93	0.72
21. Worker's compensation liability	Reg. Workplace[1]	2.56	0.89
	Telecenter[1]	2.70	0.82
	Home[1]	2.81	0.79
22. Property secure	Reg. Workplace	3.93	0.77
	Telecenter[1]	3.44	0.75
	Home[1]	3.48	0.75

[1] N = 27

Figure C-1: Supervisor Work Environment Characteristics Charts

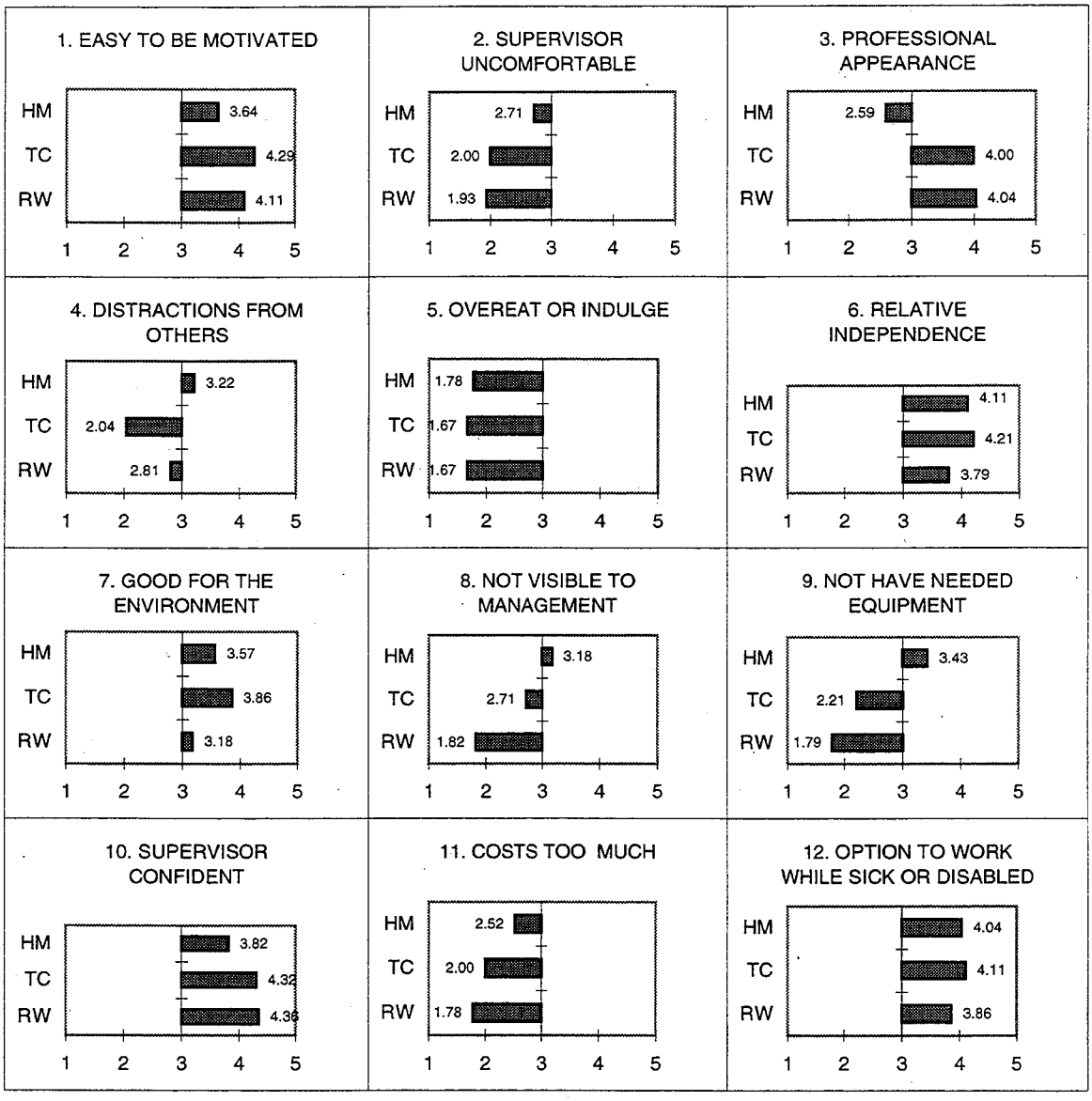


Figure C-1: Supervisor Work Environment Characteristics Charts (Continued)

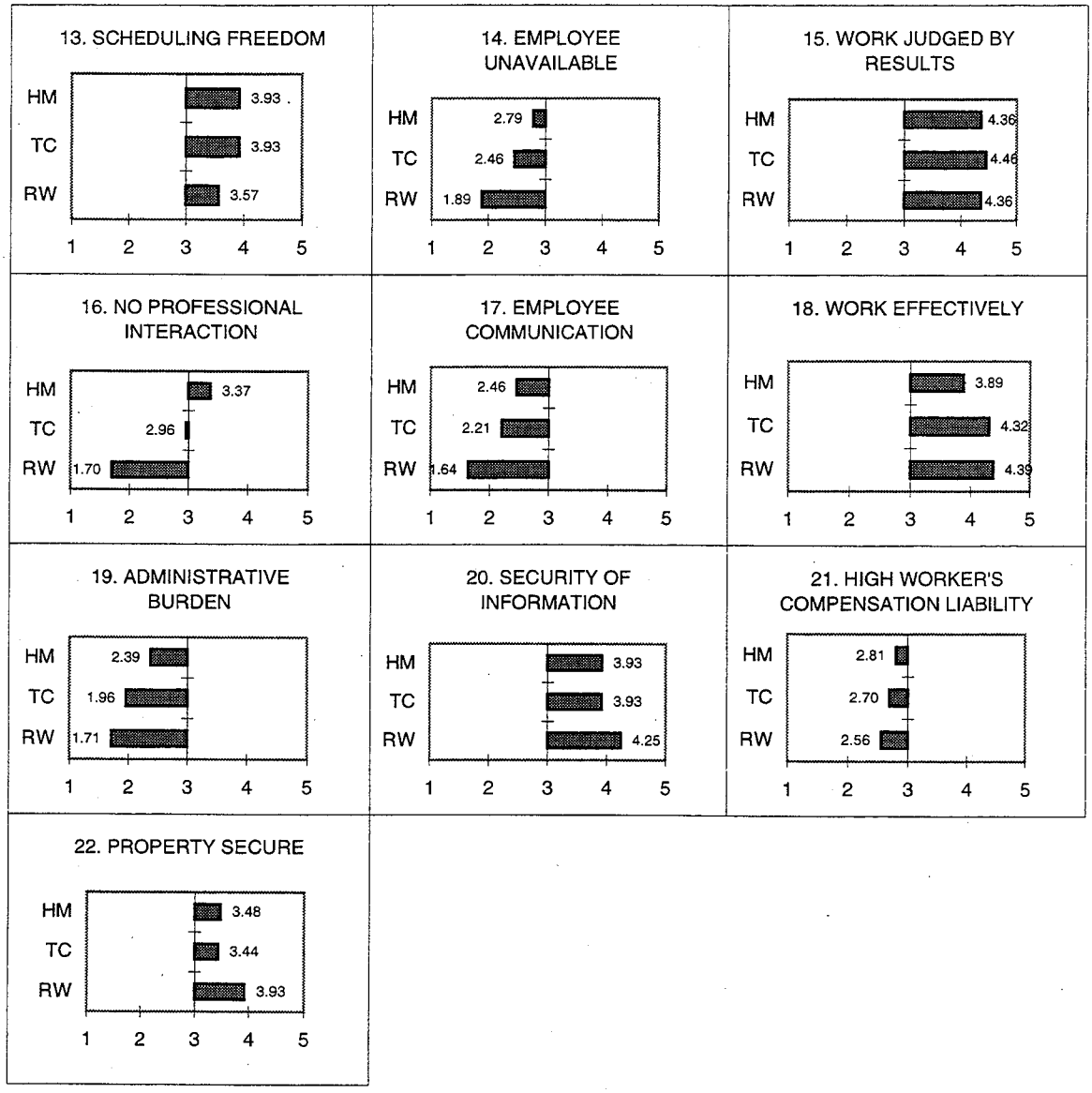
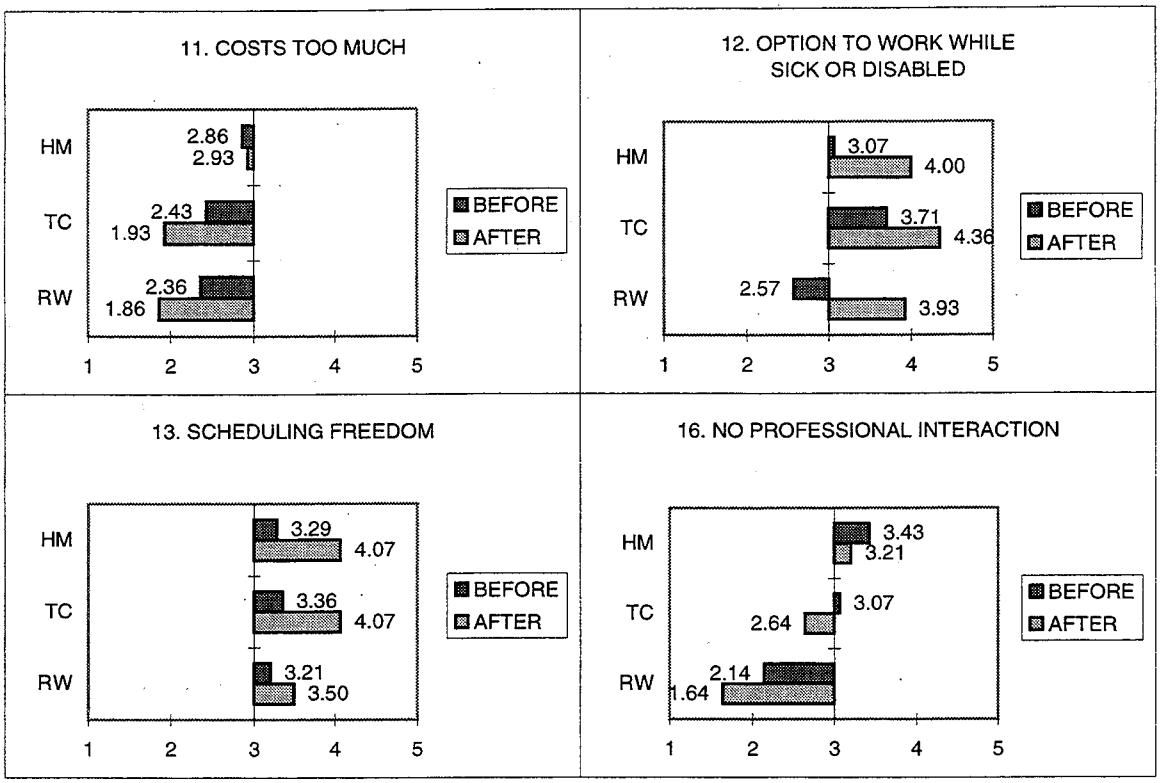


Figure C-2: Selected Supervisor Work Characteristic Attitudes from the Before and After Surveys (N = 14)



APPENDIX D

STAYERS AND QUITTERS TABULATIONS AND STATISTICAL TEST RESULTS

APPENDIX D: STAYERS AND QUITTERS TABULATIONS AND STATISTICAL TEST RESULTS

The tables in this appendix tabulate the results of statistical tests of stayers and quitters, which are described in Chapter 5. Except where noted, the sample sizes are 22 and 24 for the stayers and quitters, respectively. Significantly differing means at a level of significance of 0.10 are marked in boldface type. The calculation for telecommuting frequency (in terms of percent of days) given in Table D-1 is described in Table 3-10. Tables D-2 and D-3 report the mean response from a 5-point scale that runs from strongly disagree (1) to strongly agree (5). Table D-4 reports the mean response from a 4-point scale that runs from not at all important (1) to extremely important (4).

Table D-1: Relative Telecommuting Frequency Means (Before Survey)

Question	Stayers[1]	Quitters	t-statistic	p-value
Job suitability from a center	42.52	42.17	-0.05	0.960
Job suitability from home	22.71	27.67	0.63	0.530
Manager support from a center	37.81	41.33	0.45	0.655
Manager support from home	13.71	23.65[2]	1.55	0.128
Choice from a center	20.14	10.87[2]	-1.56	0.127
Choice from home	8.10	6.82[3]	-0.28	0.778
Preference from a center	55.90	50.21	-0.64	0.525
Preference from home	**12.16**[4]	**23.54**	**1.72**	**0.094**
Expected from a center	45.43	36.29	-1.23	0.226
Expected from home	8.95	15.48[2]	1.23	0.224

[1] N = 21 [2] N = 23 [3] N = 22 [4] N = 19

Table D-2: Job Performance and Satisfaction Means (Before Survey)

1. Respondent's Opinion	Stayers	Quitters	t-statistic	p-value
a. Amount of work	4.00	3.88	0.54	0.589
b. Quality of work	4.36	4.38	-0.06	0.953
c. Ability to meet deadlines	4.23	4.21	0.08	0.936
d. Overall productivity	4.14	4.08	0.26	0.793
2. Supervisor's Opinion				
a. Amount of work	4.00	4.21	-1.14	0.259
b. Quality of work	4.33	4.42	-0.40	0.688
c. Ability to meet deadlines	4.29	4.33	-0.22	0.823
d. Overall productivity	4.19	4.29	-0.52	0.605
3. Satisfaction Components				
a. Supervisor communication[4]	3.91	3.96	0.17	0.869
b. Promotion opportunity	3.73	4.00	-0.94	0.352
c. No lack of resources[4]	3.77	3.67	-0.32	0.754
d. Work team is effective	4.04	3.88	0.76	0.453
e. Work well with supervisor	3.82	4.13	-1.47	0.148
f. Clients are not unreasonable[4]	3.53[1]	3.35[2]	-0.49	0.626
g. Overall satisfaction	3.95	4.00	-0.16	0.874
h. Get a sense of accomplishment	4.09	4.08	0.03	0.980
i. Supervisor appreciation[4]	4.05	4.25	0.85	0.402
j. Get along well with co-workers[4]	4.59	4.58	-0.04	0.965
k. Confident in abilities	4.50	4.42	0.56	0.581
l. Unlikely to look for a new job[4]	3.05	3.67	1.62	0.112
m. Work well with those supervised	4.11[3]	4.00[3]	0.55	0.587
n. Job is tedious and boring[4]	4.05	4.08	0.15	0.879

[1] N = 17 [2] N = 20 [3] N = 9

[4] Responses were negatively worded on the survey, but changed to a positive orientation for comparison with other responses.

Table D-3: Work Environment Means (Before Survey)

Question	Location	Stayers	Quitters	t-statistic	p-value
1. Easy to be motivated	Reg. Workplace	3.50	4.00[1]	-1.86	0.070
	Telecenter	4.18	4.09[2]	0.45	0.652
	Home	3.00	3.42	-1.33	0.192
2. Stressful to work	Reg. Workplace	2.82	2.83	-0.04	0.968
	Telecenter	1.91	2.04[2]	-0.50	0.619
	Home	3.00	2.48[2]	1.70	0.097
3. Supervisor uncomfort-able	Reg. Workplace	1.86	1.67	0.90	0.370
	Telecenter	2.55	2.17	1.59	0.120
	Home	3.18	2.70[2]	1.54	0.131
4. Professional appearance	Reg. Workplace	4.09	4.17[2]	-0.44	0.661
	Telecenter	3.82	4.00[2]	-0.80	0.431
	Home	2.64	3.00[2]	-1.08	0.287
5. Distractions from others	Reg. Workplace	3.68	3.42	0.75	0.455
	Telecenter	**1.77**	**2.33**	**-2.62**	**0.012**
	Home	2.91	3.04	-0.36	0.721
6. No free time	Reg. Workplace	3.82	3.88	-0.19	0.851
	Telecenter	1.95	2.52[2]	-1.75	0.087
	Home	2.19[3]	2.17[2]	0.06	0.955
7. Overeat or indulge	Reg. Workplace	**2.59**	**1.95**	**2.14**	**0.038**
	Telecenter	**2.23**	**1.74[2]**	**2.66**	**0.011**
	Home	3.05	2.70[2]	0.95	0.348
8. Social interaction	Reg. Workplace	3.86	4.04	-0.74	0.466
	Telecenter	3.32	3.21	0.40	0.694
	Home	2.55	2.58	-0.12	0.906

[1] N = 22 [2] N = 23 [3] N = 21

Table D-3: Work Environment Means (Continued)

Question	Location	Stayers	Quitters	t-statistic	p-value
9. Relative independence	Reg. Workplace	3.64	3.78[1]	-0.54	0.590
	Telecenter	4.32	4.17	0.85	0.401
	Home	4.23	3.71	1.78	0.082
10. Convenient to run errands	Reg. Workplace	**3.36**	**2.58**	**2.46**	**0.018**
	Telecenter	3.77	3.54	0.80	0.426
	Home	3.59	3.29	0.97	0.338
11. Not enough space	Reg. Workplace	2.73	2.17	1.60	0.116
	Telecenter	2.45	2.04[1]	1.54	0.131
	Home	3.09	2.75	0.87	0.391
12. Good for the environment	Reg. Workplace	1.62[2]	1.87[1]	-1.11	0.274
	Telecenter	4.45	4.29	0.85	0.398
	Home	4.50	4.42	0.41	0.687
13. Not visible to management	Reg. Workplace	2.14	1.91[1]	0.86	0.393
	Telecenter	2.86	2.74[1]	0.39	0.698
	Home	3.14	3.25	-0.31	0.757
14. Not have needed equipment	Reg. Workplace	1.91	1.75	0.76	0.453
	Telecenter	1.81[2]	2.09[1]	-1.44	0.157
	Home	2.95	3.21	-0.66	0.513
15. Keep home and work separate	Reg. Workplace	1.95	1.70[1]	1.22	0.230
	Telecenter	1.73	1.91[1]	-1.17	0.248
	Home	2.82	3.33	-1.29	0.204
16. Control over environment	Reg. Workplace	2.27	2.39[1]	-0.39	0.702
	Telecenter	3.33[2]	3.08	0.80	0.426
	Home	4.23	3.75	1.61	0.114

[1] N = 23 [2] N = 21

Table D-3: Work Environment Means (Continued)

Question	Location	Stayers	Quitters	t-statistic	p-value
17. Cost too much	Reg. Workplace	3.59	2.92	1.88	0.067
	Telecenter	1.77	1.87[1]	-0.52	0.603
	Home	2.09	2.13[1]	-0.13	0.894
18. Commute is a hassle	Reg. Workplace	4.36	4.08	1.07	0.292
	Telecenter	1.50	1.88	-1.72	0.093
	Home	1.41	1.38	0.19	0.853
19. Work while sick or disabled	Reg. Workplace	1.81[2]	2.08	-1.08	0.287
	Telecenter	3.14[2]	3.28	-0.34	0.739
	Home	3.86	4.33	-1.81	0.077
20. Scheduling freedom	Reg. Workplace	3.64	3.04	1.75	0.086
	Telecenter	4.14	3.75	1.56	0.127
	Home	3.95	4.17	-0.90	0.375
21. Can handle dependent care	Reg. Workplace	1.67[3]	2.50[4]	-1.72	0.102
	Telecenter	3.67[3]	4.15[5]	-1.27	0.219
	Home	3.67[3]	4.50[4]	-2.00	0.060
22. Work judged by results	Reg. Workplace	3.86[2]	3.88	-0.06	0.950
	Telecenter	3.62[2]	4.00	-1.38	0.176
	Home	3.52[2]	4.00	-1.59	0.119
23. Household conflicts	Reg. Workplace	2.00[6]	2.44[7]	-1.33	0.194
	Telecenter	2.20[8]	1.78[7]	1.83	0.077
	Home	3.07[8]	2.50[7]	1.28	0.209
24. Save me money	Reg. Workplace	2.00	1.87[1]	0.44	0.663
	Telecenter	4.27	4.00	0.88	0.383
	Home	4.09	4.04	0.15	0.882

[1] N = 23 [2] N = 21 [3] N = 9 [4] N = 12 [5] N = 13 [6] N = 16
[7] N = 18 [8] N = 15

Table D-3: Work Environment Means (Continued)

Question	Location	Stayers	Quitters	t-statistic	p-value
25. Requires self-discipline	Reg. Workplace	2.23	2.38	-0.49	0.625
	Telecenter	2.18	2.58	-1.29	0.205
	Home	3.32	3.83	-1.31	0.197
26. No professional interaction	Reg. Workplace	**2.36**	**1.78**[1]	**2.05**	**0.047**
	Telecenter	2.57[2]	2.88	-1.01	0.320
	Home	3.05[2]	3.38	-0.94	0.353
27. Dress the way I like	Reg. Workplace	2.68	2.96	-0.79	0.433
	Telecenter	4.18	3.92	1.44	0.157
	Home	4.45	4.33	0.66	0.510
28. Balance respon-sibilities	Reg. Workplace	2.86	2.70[1]	0.45	0.655
	Telecenter	3.86	4.00[1]	-0.60	0.549
	Home	3.23	3.67	-1.38	0.175
29. Supervisor communi-cation	Reg. Workplace	2.00	1.92	0.34	0.733
	Telecenter	2.14[2]	2.21	-0.24	0.808
	Home	2.33[2]	2.58	-0.73	0.469
30. Work effectively	Reg. Workplace	4.05	3.91[1]	0.49	0.624
	Telecenter	4.41	4.04	1.83	0.073
	Home	3.64	3.57[1]	0.19	0.849

[1] N = 23 [2] N = 21

Table D-4: Work Characteristic Importance Rating Means (Before Survey)

Characteristic	Stayers	Quitters	t-statistic	p-value
1. Being motivated to work	3.32	3.50	-0.76	0.450
2. Working with little stress	3.00	2.88	0.51	0.614
3. Supervisor be comfortable	3.55	3.46	0.53	0.596
4. Professional environment	2.68	2.42	0.89	0.377
5. Working with no distractions	3.09	3.13	-0.14	0.890
6. Spending time with family/friends	3.36	3.08	1.04	0.306
7. Not overeating or indulging	2.59	2.79	-0.58	0.567
8. Interacting socially at work	2.59	2.63	-0.13	0.894
9. Having work independence	3.45	3.63	-0.99	0.329
10. Running errands while commuting	2.50	2.38	0.44	0.663
11. Having enough work space	3.32	3.29	0.15	0.881
12. Benefitting the environment	3.14	2.92	0.80	0.430
13. Being visible to management	2.36	2.42	-0.21	0.836
14. Having needed equipment	**3.68**	**3.96**	**-2.23**	**0.031**
15. Separating home and work	3.09	2.96	0.42	0.678
16. Having control over work area	3.36	3.46	-0.49	0.628
17. Not spending own money on work	3.00[1]	2.91[2]	0.30	0.769
18. Commuting without a hassle	3.41	3.58	-0.75	0.456
19. Working while sick or disabled	2.27	2.54	-0.98	0.334
20. Able to change work schedule	3.27	3.46	-0.85	0.402
21. Able to care for dependent(s)	2.14	2.29	-0.42	0.678
22. Work judged by results	3.77	3.83	-0.45	0.656
23. Minimizing household conflicts	3.05	2.92	0.43	0.668
24. Saving money on work expenses	3.23	3.17[2]	0.20	0.844
25. Having strong self-discipline	3.45	3.58	-0.70	0.490

[1] N = 21 [2] N = 23

Table D-4: Work Characteristic Importance Rating Means (Continued)

Characteristic	Stayers	Quitters	t-statistic	p-value
26. Interacting professionally	3.14	2.88	1.05	0.299
27. Dressing the way I like	**2.91**	**3.38**	**2.02**	**0.050**
28. Balancing home and work	2.95	3.00[1]	-0.17	0.867
29. Communicating with supervisor	3.41	3.51	-0.62	0.540
30. Working effectively	3.82	3.96	-1.53	0.133

[1] N = 23

APPENDIX E

"AFTER" TELECOMMUTING CENTER EMPLOYEE SURVEY

APPENDIX E

"AFTER" TELECOMMUTING CENTER EMPLOYEE SURVEY

Name: _____ **Date:** _____
(please print) *(month / day / year)*

Employer: _____ **Work Phone:** (_____)_____

PART A YOUR JOB CHARACTERISTICS

To begin, we would like to know about various aspects of your work.

1. Which of the following best describes your current work?

   ☐$_1$ Manager / Administrator
   ☐$_2$ Professional / Technical
   ☐$_3$ Services / Repair
   ☐$_4$ Other (*please specify*): _____
   ☐$_5$ Administrative support
   ☐$_6$ Sales / Marketing
   ☐$_7$ Production / Construction / Crafts

2. How long have you worked. . .

   a. for your immediate supervisor? _____ years (*check here if self-employed*: ☐$_1$)
   b. for your present employer? _____ years
   c. in your present occupation? _____ years

3. About how many people work for your organization at your regular workplace? (*This workplace may include multiple adjacent buildings occupied by the same organization.*)

   ☐$_1$ 1 - 9
   ☐$_2$ 10 - 49
   ☐$_3$ 50 - 99
   ☐$_4$ 100 - 499
   ☐$_5$ 500 - 999
   ☐$_6$ 1000 or more

4. At what time do you usually. . .

   a. arrive at work? _____ (*Please indicate a.m. or p.m.*)
   b. leave work? _____ (*Please indicate a.m. or p.m.*)

5. Please indicate your **normal, official** work hour arrangement. (*Check the single most appropriate response.*)

   ☐$_1$ **Part-time:** _____ hours per week (over ____ days)

   ☐$_2$ **Conventional** (full-time, with a start time between 8 and 9 a.m.)

   ☐$_3$ **Fixed flextime** (full-time, with a fixed start time outside 8 to 9 a.m.)

   ☐$_4$ **Variable flextime** (full-time, with a variable start time)

   ☐$_5$ **Compressed work week** (9 to 10 hours per day, with a day off every one or two weeks)

   ☐$_6$ **Other** (*please specify*): _____

6. The actual number of hours you work may differ from your official arrangement – for example, due to paid and unpaid overtime. Keeping in mind that **there are 75 - 80 work hours** in a full-time **two-week period**, how many hours in a **two-week** period do you usually work? (*Include paid and unpaid overtime.*)

   _____ hours in two weeks

7. Please indicate the approximate **percent of time** you generally spend on each of the following categories of work-related activities. If some of your activities fall into more than one category, please select the single most important category for that activity. **Your answers should add to 100%.**

   _____ Work you do **independently** (like reading, thinking, writing, planning)

   _____ Work you do with others, **face to face** (like face-to-face meetings or conversations)

   _____ Work you do with others, **remotely** (like making or receiving telephone calls)

   _____ Work that must be done at a **specific location** (like site visits, service or maintenance)

   _____ Work-related **travel** (only the actual time spent traveling)

   _____ Other (*please specify*): _____

   100%

8. Which of the following features did you use, did you need, or would you like to have available at the telecommuting center? (*Check all that apply.*)

	Used while at the center	*Needed, but did not have*	*Would like, but not essential*
a. Additional phone line	☐$_1$	☐$_2$	☐$_3$
b. Voice mail / Answering machine	☐$_1$	☐$_2$	☐$_3$
c. Call forwarding	☐$_1$	☐$_2$	☐$_3$
d. Call waiting	☐$_1$	☐$_2$	☐$_3$

	Used while at the center	*Needed, but did not have*	*Would like, but not essential*
e. Conference calling	☐1	☐2	☐3
f. Video-conferencing	☐1	☐2	☐3
g. Personal computer or workstation	☐1	☐2	☐3
h. Software used at work	☐1	☐2	☐3
i. Electronic mail	☐1	☐2	☐3
j. Files or reference materials	☐1	☐2	☐3
k. Fax machine	☐1	☐2	☐3
l. Printer	☐1	☐2	☐3
m. Modem	☐1	☐2	☐3
n. Copier	☐1	☐2	☐3
o. Secretarial services	☐1	☐2	☐3
p. Document production services	☐1	☐2	☐3
q. Overnight package pick up / delivery	☐1	☐2	☐3
r. Private office	☐1	☐2	☐3
s. Lockable storage area	☐1	☐2	☐3
t. Child care	☐1	☐2	☐3
u. Restaurant / Cafeteria	☐1	☐2	☐3
v. Other (*please specify*): _____	☐1	☐2	☐3

9. Were there work-related activities that you expected to do while telecommuting that you were unable to do?

☐1 No → (*Go to Part B*) ☐2 Yes (*Answer Question 9a*)

↓

9a. Aside from responses you may have checked in Question 8, why were you unable to complete these tasks while telecommuting? (*Check all that apply.*)

☐1 The items checked in Question 8 were the only reasons.
☐2 Technical difficulties
☐3 Security concerns
☐4 Employer restrictions
☐5 Other (*please specify*): _____
☐6 Haven't telecommuted as much as expected.
☐7 Need for face-to-face interaction
☐8 Too many distractions
☐9 Not enough telecommuting experience

PART B
YOUR JOB SATISFACTION

Next, we would like to know how you feel about your job. There are no "right" or "wrong" answers; we want only your honest opinions. We remind you that your responses are strictly confidential.

1. Please rate **yourself** on the following aspects of your job.

	Terrible	*Poor*	*Average*	*Good*	*Excellent*
a. The amount of work you get done	☐1	☐2	☐3	☐4	☐5
b. The quality of your work	☐1	☐2	☐3	☐4	☐5
c. Your ability to meet deadlines	☐1	☐2	☐3	☐4	☐5
d. Your overall productivity	☐1	☐2	☐3	☐4	☐5

2. In your opinion, how would **your supervisor** rate you on the following aspects of your job?

	Terrible	*Poor*	*Average*	*Good*	*Excellent*
a. The amount of work you get done	☐1	☐2	☐3	☐4	☐5
b. The quality of your work	☐1	☐2	☐3	☐4	☐5
c. Your ability to meet deadlines	☐1	☐2	☐3	☐4	☐5
d. Your overall productivity	☐1	☐2	☐3	☐4	☐5

3. For each of the following statements, please check the answer that best expresses your opinion.

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
a. My supervisor and I don't communicate effectively.	☐1	☐2	☐3	☐4	☐5
b. I have the same opportunity for promotion as anyone who is similarly qualified (regardless of telecommuting).	☐1	☐2	☐3	☐4	☐5
c. I am frustrated by a lack of adequate resources to do my job.	☐1	☐2	☐3	☐4	☐5
d. My work team is effective.	☐1	☐2	☐3	☐4	☐5
e. My supervisor and I work well together.	☐1	☐2	☐3	☐4	☐5
f. My job is tedious and boring.	☐1	☐2	☐3	☐4	☐5

		Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
g.	Working at my job gives me a sense of accomplishment.	☐1	☐2	☐3	☐4	☐5
h.	My supervisor doesn't appreciate my work effort enough.	☐1	☐2	☐3	☐4	☐5
i.	I am confident in my ability to do what is expected of me at work.	☐1	☐2	☐3	☐4	☐5
j.	I don't get along well with my co-workers.	☐1	☐2	☐3	☐4	☐5
k.	I am likely to look for a new job within the next six months.	☐1	☐2	☐3	☐4	☐5
l.	I work well with those I supervise. (*check here if not applicable*: ☐6)	☐1	☐2	☐3	☐4	☐5
m.	Customers or clients tend to make unreasonable demands on my time. (*check here if not applicable*: ☐6)	☐1	☐2	☐3	☐4	☐5
n.	Overall, I am satisfied with my job.	☐1	☐2	☐3	☐4	☐5

PART C
DIFFERENT WORK ENVIRONMENTS

This section asks for your opinions on various aspects of ***three different workplaces****: the regular workplace, the telecommuting center, and home. Although you may not have previously telecommuted from home, you probably have an idea of what it would be like. Your opinions may depend on how much you would be telecommuting; assume that you would be doing as much or as little as you wanted to. Please answer the questions below* ***for each workplace.***

		Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1.	It would be easy for me to be motivated when I work from					
	a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
	b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
	c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
2. It would be stressful to work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
3. My supervisor would be uncomfortable when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
4. The workplace would have a professional appearance at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
5. Distractions from other people would be a problem when I work at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
6. It would save me money to work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
7. I wouldn't have enough space to work at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
8. I wouldn't have a lot of free time to be with my family and/or friends when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
9. I would have enough opportunities for social interaction with fellow employees and others at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
10. It would be convenient to run errands when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
11. I would probably overeat or indulge in other ways when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
12. It would be beneficial to the environment to work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
13. I wouldn't be visible enough to management if I worked at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
14. I wouldn't have the needed equipment and services to work effectively at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
15. I would have difficulty keeping my home and work activities separate when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
16. I would have control over my work environment (temperature, noise, etc.) when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
17. It would cost me too much money to work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
18. My commute would be a hassle when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
19. When sick or disabled, I would be able to work at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
20. I would have the freedom to adjust my work schedule when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
21. I would have the flexibility to handle dependent care (child or adult) when I work from (*check here if not applicable*: ☐6)					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
22. The merit of my work would be judged primarily by the results if I worked from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
23. I would have conflicts with members of my household when I work from (*check here if not applicable*: ☐6)					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
24. I would have relative independence in my day-to-day activities when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
25. It would take a lot of self-discipline to work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
26. I wouldn't have enough opportunities for professional interaction at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
27. I would be able to dress the way I like at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
28. I could effectively balance work and household responsibilities when I work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
29. Communication with my supervisor would be a problem when I work at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
30. I would work effectively at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

PART D
AMOUNT OF TELECOMMUTING

This section asks about your experience with telecommuting and to what extent telecommuting is possible and desirable for you. It also asks about the time you may save by telecommuting.

1. Including all of your past telecommuting experiences, what total length of time have you telecommuted? (*Do not include overtime or self-employment at home.*)

   a. _____ years and _____ months from **home**

   b. _____ years and _____ months from a **telecommuting center**

2. Does your employer require you to telecommute? ☐1 No ☐2 Yes

3. Does your employer offer you the option to telecommute from home?

   ☐1 No ☐2 Yes

4. Is the telecommuting center your organization's primary local place of business?

   ☐$_1$ No ☐$_2$ Yes

5. Given your current circumstances, what would be the **ideal** distribution of your work time among each of the following locations? Please give the average percentage of time you would prefer to work at each location. **Your answers should add to 100%.**

   _____ regular workplace

   _____ telecommuting center

   _____ home

   _____ other (*please specify*): _____

   100%

6. If the telecommuting center were not available, what would be the ideal distribution of your work time among each of the following locations? **Your answers should add to 100%.**

   _____ regular workplace

   _____ home

   _____ other (*please specify*): _____

   100% of total work time

7. On days that you telecommute, how do you use the time you would normally spend commuting to the regular workplace? These activities may or may not take place during the actual times of the day that you formerly spent commuting. Please select the general types of activities below that best describe how you use any time you may save by telecommuting. (*Check all that apply.*)

   ☐$_1$ No significant time saved
   ☐$_2$ Work
   ☐$_3$ Shop
   ☐$_4$ Get more sleep
   ☐$_5$ Spend time with family / friends
   ☐$_6$ Spend time on a hobby
   ☐$_7$ Attend a class
   ☐$_8$ Participate in an outdoor activity / sport
   ☐$_9$ Exercise
   ☐$_{10}$ Housework / Yardwork
   ☐$_{11}$ Cook
   ☐$_{12}$ Support a cause I believe in
   ☐$_{13}$ Relax by myself (read, watch TV, etc.)
   ☐$_{14}$ Other (*please specify*): _____

8. From the list in Question 7 (items 1-14), please select the activity that you do most frequently with any time you may save by telecommuting. Enter a "1" if no significant time was saved.

   The number of the most frequent activity is _____.

*Please answer **each** question below, both for a telecommuting center and for home. By **"occasional partial days"** we mean a situation in which you telecommute for part of the work day and go to the regular workplace for the rest of the day.*

	Not at all	*Less than once a month*	*About 1-3 days a month*	*1-2 days a week*	*3-4 days a week*	*5 days a week*	*Occa-sional partial days*
9. Considering the requirements of your current job, how much do you think **the nature of your job** would allow you to telecommute							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
10. Considering the characteristics of your current supervisor, how much do you think **your supervisor** would let you telecommute							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
11. How much do you **currently** telecommute							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
12. Assuming that there are no work-related constraints, how much **would you like** to telecommute							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
13. Six months from now, how much **do you expect** to be telecommuting							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART E
YOUR TRAVEL CHARACTERISTICS

Next, we would like some information about your travel to and from work.

1. On average, how long does it take for you to commute (one way) between home and. . .
   a. *the regular workplace?* _____ minutes
   b. *the telecommuting center?* _____ minutes

2. How far (one way) is your home from. . .
   a. *the regular workplace?* _____ miles
   b. *the telecommuting center?* _____ miles

3. Is public transit (bus, light rail, etc.) easily accessible from your home?
   ☐$_1$ No ☐$_2$ Yes ☐$_3$ Don't know

4. What is your approximate **cost per month** for each of the following **commute travel** expenses?
   $_____ fuel (commuting only) $_____ transit fare
   $_____ parking $_____ carpool / vanpool fee
   $_____ tolls $_____ other (*please specify*): _____

5. Have you changed where you live within the past year?
   ☐$_1$ No → (*Go to Question 6*) ☐$_2$ Yes, closer to work → (*Answer 5a and b*)
   ☐$_3$ Yes, farther from work → (*Answer 5a and b*)

   5a. Was the ability to telecommute an important factor in your decision to move?
   ☐$_1$ Not at all ☐$_3$ Very important
   ☐$_2$ Somewhat important ☐$_4$ The most important factor

   5b. Was the location of a telecommuting center an important factor in choosing **where** to move?
   ☐$_1$ Not at all ☐$_3$ Very important
   ☐$_2$ Somewhat important ☐$_4$ The most important factor

6. Are you considering changing where you live?

☐$_1$ No → *(Go to Question 7)*

☐$_2$ Yes, closer to work → *(Answer 6a and b)*

☐$_3$ Yes, farther from work → *(Answer 6a and b)*

☐$_4$ Yes, either closer or farther → *(Answer 6a and b)*

6a. Is the ability to telecommute an important factor in your consideration of **whether** to move?

☐$_1$ Not at all

☐$_2$ Somewhat important

☐$_3$ Very important

☐$_4$ The most important factor

6b. Is the location of a telecommuting center an important factor in considering **where** to move?

☐$_1$ Not at all

☐$_2$ Somewhat important

☐$_3$ Very important

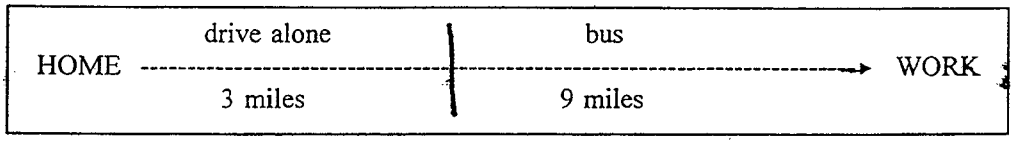
☐$_4$ The most important factor

7. In a typical month (think of it as 20 working days), how many times do you do each of the following during your lunch break? Please distinguish between days that you work from the regular workplace and days that you work from the telecommuting center.

	Regular Workplace	*Telecommuting Center*
a. Bring lunch from home	_____	_____
b. Buy lunch at the workplace	_____	_____
c. Eat at home	_____	_____
d. Walk someplace other than home to buy lunch and/or run errands	_____	_____
e. Drive or ride to someplace other than home to buy lunch and/or run errands	_____	_____
f. Take public transit to someplace other than home to buy lunch and/or run errands	_____	_____
g. Take a taxi to someplace other than home to buy lunch and/or run errands	_____	_____
h. Skip lunch	_____	_____
i. Other (*please specify*): _____	_____	_____
	---	---
20 days =	_____	+ _____

You probably use one or more of the following modes, or means of transportation, to get to work: driving alone, carpool, vanpool, bus, train, bicycle, jogging, or walking. We need to know what that trip looks like in terms of which modes you use. The simplest way to indicate that is through a diagram. For example, if you drive alone 3 miles to a park-and-ride lot, where you take a bus the rest of the way to work (say 9 miles), your diagram would look like this:

Example:



Of course, you may use more than one pattern on different occasions. For example, you may carpool 4 days a week and drive alone the other day. Or, you may take the bus 95% of the time, but about once a month, you need to drive your car to work. We are interested in these various patterns.

8. Please use the diagrams below to illustrate the one or two patterns you most often use to get to your **regular workplace**. Be sure that each diagram has (a) the **means of transportation** you use for each segment of the trip; (b) the approximate **length in miles** of each segment; and (c) the **percent of the time** you use this particular pattern in terms of the *total number of days that you commute to your regular workplace.*

% of commuting days this pattern is used

HOME ----------▸ REGULAR WORKPLACE _____

HOME ----------▸ REGULAR WORKPLACE _____

9. Using the same format as in the question above, illustrate the patterns you use most often to get to the **telecommuting center**. Be sure that each diagram has (a) the **means of transportation**; (b) the approximate **length in miles** of each segment; and (c) the **percent of the time** you use this particular pattern in terms of the *total number of days that you work from the telecommuting center.*

% of telecommuting days this pattern is used

HOME ----------▸ TELECOMMUTING CENTER _____

HOME ----------▸ TELECOMMUTING CENTER _____

PART F
GENERAL INFORMATION

In this section we ask for some background information about you and your household. By household members we mean "people who live together and share at least some activities and financial resources" (exclude ordinary roommates who simply share living expenses). Your answers to these questions are important to help us generalize the findings from this small sample to the population as a whole. Again, your responses are strictly confidential.

1. Please indicate the number of your household members (including yourself) which fall into the different age groups given below.

   _____ persons under 2 years old
   _____ persons 2 - 5 years old
   _____ persons 6 - 15 years old
   _____ persons 16 - 24 years old
   _____ persons 25 - 60 years old
   _____ persons older than 60 years

2. Is there anyone in your household (other than preschoolers) who needs special care?

   ☐$_1$ No ☐$_2$ Yes

3. How many full-time and part-time workers (including yourself) are there in your household?

   _____ full-time workers _____ part-time workers

4. Do you have a valid driver's license? ☐$_1$ No ☐$_2$ Yes

5. Not including yourself, how many **other** household members have a driver's license? _____

6. How many motor vehicles (motorcycles, cars, vans, and light duty trucks) are available to your household – whether owned, leased, or employer-provided? (*Exclude vehicles used only off-road.*)

   _____ gasoline or diesel vehicles (cars, vans, and light duty trucks)
   _____ alternative fuel vehicles (electric, methanol, natural gas, etc.)
   _____ motorcycles

7. Please check the category which contains your approximate **annual household** income **before** taxes.

   ☐$_1$ Less than $15,000
   ☐$_2$ $15,000 to $24,999
   ☐$_3$ $25,000 to $34,999
   ☐$_4$ $35,000 to $54,999
   ☐$_5$ $55,000 to $74,999
   ☐$_6$ $75,000 or more

COMMENTS: We would value any additional comments you may have. Please write them below, and/or attach another page. Thank you for your time and cooperation!

APPENDIX F

"AFTER" SURVEY FOR MANAGERS OF TELECOMMUTING CENTER USERS

APPENDIX F

"AFTER" SURVEY FOR MANAGERS OF TELECOMMUTING CENTER USERS

Your name: _____ **Date:** _____
(please print) *(month / day / year)*

Employer: _____ **Work phone:** (_____)_____

Name of participating employee: _____

PART A
YOUR EMPLOYEE'S JOB

To begin, we would like to ask a couple of background questions about your employee's job.

1. The average number of hours in a full-time **two-week work period** is 75 - 80 hours. How many hours in a **two-week** period does your employee usually work? We are looking for the actual number of hours worked, including paid and unpaid overtime.

   _____ actual hours worked in two weeks

2. Which of the following items or services should a telecommuting center provide so that your employee could work **as effectively** as at the regular workplace? (*Check all items that apply.*)

☐$_1$ Additional phone line	☐$_{12}$ Printer
☐$_2$ Voice mail / Answering machine	☐$_{13}$ Modem
☐$_3$ Call forwarding	☐$_{14}$ Copier
☐$_4$ Call waiting	☐$_{15}$ Secretarial services
☐$_5$ Conference calling	☐$_{16}$ Document production services
☐$_6$ Video-conferencing	☐$_{17}$ Overnight package pickup / delivery
☐$_7$ Personal computer or workstation	☐$_{18}$ Private office
☐$_8$ Software used at work	☐$_{19}$ Lockable storage area
☐$_9$ Electronic mail	☐$_{20}$ Child care
☐$_{10}$ Files or reference materials	☐$_{21}$ Restaurant / Cafeteria
☐$_{11}$ Fax machine	☐$_{22}$ Other (*please specify*): _____

PART B
ASSESSMENT OF YOUR EMPLOYEE

Next, we would like to know how you view various aspects of your employee's work effectiveness, and your relationship with your employee. There are no "right" or "wrong" answers to the questions below. We want only your honest opinions. We remind you that your responses are strictly confidential.

1. Please rate **your employee** on the following aspects of his/her job.

		Terrible	*Poor*	*Average*	*Good*	*Excellent*
a.	Amount of work accomplished	☐1	☐2	☐3	☐4	☐5
b.	Quality of work	☐1	☐2	☐3	☐4	☐5
c.	Ability to meet deadlines	☐1	☐2	☐3	☐4	☐5
d.	Overall productivity	☐1	☐2	☐3	☐4	☐5

2. For each of the following statements, please check the answer that best expresses your opinion.

		Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
a.	My employee and I don't communicate effectively.	☐1	☐2	☐3	☐4	☐5
b.	Adequate resources are not available for my employee to do the job.	☐1	☐2	☐3	☐4	☐5
c.	My employee's work team is effective.	☐1	☐2	☐3	☐4	☐5
d.	My employee and I work well together.	☐1	☐2	☐3	☐4	☐5
e.	Customers or clients tend to make unreasonable demands on my employee's time. (*check here if not applicable*: ☐6)	☐1	☐2	☐3	☐4	☐5
f.	Overall, I am satisfied with my employee's performance.	☐1	☐2	☐3	☐4	☐5
g.	I don't express enough appreciation for my employee's work effort.	☐1	☐2	☐3	☐4	☐5
h.	My employee doesn't get along well with co-workers.	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
i. My employee has the ability to do what is expected at work.	☐1	☐2	☐3	☐4	☐5
j. My employee is likely to look for a new job in the next six months.	☐1	☐2	☐3	☐4	☐5
k. My employee works well with those he/she supervises. (*check here if not applicable*: ☐6)	☐1	☐2	☐3	☐4	☐5

PART C
DIFFERENT WORK ENVIRONMENTS

This section asks for your opinions on various aspects of ***three different workplaces****: the regular workplace, the telecommuting center, and the employee's home. Although your employee may not have previously telecommuted from home, you probably have an idea of how telecommuting would affect him/her. Assume* ***in this section*** *that your employee would telecommute "some, but not too much". (In Part E we ask you what amount of telecommuting, if any, would be ideal for your employee). Please answer the questions below* ***for each workplace****.*

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1. It would be easy for my employee to be motivated when working from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
2. I would be uncomfortable when my employee worked from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
3. The workplace would have a professional appearance at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
4. Distractions from other people would be a problem when my employee worked at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
5. I am concerned that my employee would indulge in ways that would be detrimental to his/her health when working from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
6. My employee would have relative independence in his/her day-to-day activities when working from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
7. It would be beneficial to the environment for my employee to work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
8. My employee wouldn't be visible enough to management if he/she worked at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
9. My employee wouldn't have the needed equipment and services to work effectively from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
10. I feel confident that my employee would work a full day when working from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
11. It would cost our organization too much money for my employee to work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
12. When sick or disabled, I would offer my employee the option to work from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
13. My employee would have the freedom to adjust his/her work schedule when working from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
14. I'm concerned that my employee would often be unavailable when needed, while working at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
15. The merit of my employee's work would be judged primarily by the results if he/she worked from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
16. My employee wouldn't have enough opportunities for professional interaction at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
17. Communication with my employee would be a problem when he/she works at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
18. My employee would work effectively at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
19. It would be an administrative burden on me for my employee to work at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
20. Security of confidential information could be handled effectively when my employee worked from					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
21. Our organization's liability for worker's compensation would be high at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5
22. Our organization's property would be relatively secure from theft or damage at					
a. *the regular workplace.*	☐1	☐2	☐3	☐4	☐5
b. *the telecommuting center.*	☐1	☐2	☐3	☐4	☐5
c. *home.*	☐1	☐2	☐3	☐4	☐5

PART D
POTENTIAL ADVANTAGES OF TELECOMMUTING

Some of the statements in the previous section dealt with potential disadvantages of telecommuting. Here, we would like to focus on some of the potential advantages. How significant (if at all) are each of the following factors as ***advantages of telecommuting?*** *Your personal views of the importance of these factors may differ from what your organization has officially expressed. Please rate each factor first according to your* ***personal opinion****, and second according to the* ***official view*** *of your organization. (Note: please distinguish between* ***"no opinion"*** *and the opinion that the factor is* ***"not a significant advantage").***

	No Opinion	*Not Significant*	*Moderately Significant*	*Extremely Significant*
1. Improved employee retention (reduced turnover)				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
2. Savings on office space costs				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
3. Better customer service				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4

	No Opinion	*Not Significant*	*Moderately Significant*	*Extremely Significant*
4. Improved ability to recruit employees				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
5. Increased productivity				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
6. Savings on parking costs				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
7. Improved disaster response capability				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
8. Reduced absenteeism				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
9. Reduced health costs				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
10. Compliance with environmental regulations				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
11. Improved employee relations				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4
12. Other (*please specify*): _____				
a. *Your opinion*	☐1	☐2	☐3	☐4
b. *Official viewpoint*	☐1	☐2	☐3	☐4

PART E
TELECOMMUTING AS A WORK OPTION

This section asks about your experience with telecommuting, and to what extent telecommuting may be possible or desirable for your organization in general and your employee in particular. Also, we ask about your reactions and those of your organization to telecommuting from a center.

1. Is there a formal policy addressing the issue of telecommuting within your organization? (*Please answer separately for each level.*)

	No	*Yes, Against Telecommuting*	*Yes, Supporting Telecommuting*	*Don't Know*
a. Organization-wide	☐1	☐2	☐3	☐4
b. Your supervisor	☐1	☐2	☐3	☐4
c. Yourself	☐1	☐2	☐3	☐4

2. Regardless of the existence of a formal policy, what is the general attitude toward telecommuting at each of the following levels?

	Negative	*Neutral*	*Positive*	*Don't Know*
a. Organization	☐1	☐2	☐3	☐4
b. Your supervisor	☐1	☐2	☐3	☐4
c. Yourself	☐1	☐2	☐3	☐4

3. Including all of your past experience as a manager, what total length of time have you supervised employees who telecommute. . .

   a. from a **telecommuting center**? _____ years and _____ months

   b. from **home**? _____ years and _____ months

4. Within the next two years, what change do you expect to see in the proportion of your organization's workforce allowed to telecommute. . .

	Decrease	*No Change*	*Increase*	*Don't Know*
a. from a **telecommuting center**?	☐1	☐2	☐3	☐4
b. from **home**?	☐1	☐2	☐3	☐4

5. Overall, how would you rate **your level of satisfaction** with center-based telecommuting?

   ☐1 Very low ☐2 Low ☐3 Neutral ☐4 High ☐5 Very high

6. With the center in its current state, how likely is your organization to offer center-based telecommuting to other employees?

☐$_1$ Very unlikely ☐$_2$ Unlikely ☐$_3$ Not sure ☐$_4$ Likely ☐$_5$ Very likely

7. What, if anything, would need to change to make your organization **likely** to offer center-based telecommuting? Please explain **how** and/or **why** the indicated item would need to change. (*Check all that apply.*)

		Explanation
☐$_1$	Nothing would make the organization likely to offer it	_____
☐$_2$	Nothing more is needed, we are already likely to offer it	_____
☐$_3$	The cost	_____
☐$_4$	The ability to quantify benefits to the organization	_____
☐$_5$	Security	_____
☐$_6$	Use of the center by competitors	_____
☐$_7$	Private offices	_____
☐$_8$	Appearance of the center	_____
☐$_9$	Size of the center	_____
☐$_{10}$	Location of the center	_____
☐$_{11}$	Equipment	_____
☐$_{12}$	Site administration	_____
☐$_{13}$	Clerical support	_____
☐$_{14}$	Manager acceptance	_____
☐$_{15}$	Employee acceptance	_____
☐$_{16}$	Support on selection and training of telecommuters	_____
☐$_{17}$	Other (*please specify*): _____	_____

8. From the list in Question 7 (items 1-17), please select the most important factor that would make your organization likely to offer center-based telecommuting. Enter a "1" if nothing would make the organization likely to offer it and a "2" if the organization is already likely to offer it.

The number of the most important factor is _____.

9. Given the current circumstances, what would be the ideal distribution of your employee's time among each of the following work locations? Please give the **average percentage of time** you would prefer your employee to work at each location. **Your answers should add to 100%.**

_____ regular workplace _____ home

_____ telecommuting center _____ other (*please specify*): _____

*Please answer **each** question below, both for a telecommuting center and for home. By **"occasional partial days"** we mean a situation in which your employee telecommutes for part of the work day and then goes to the regular workplace for the rest of the day.*

	Not at all	*Less than once a month*	*About 1-3 days a month*	*1-2 days a week*	*3-4 days a week*	*5 days a week*	*Occa-sional partial days*
10. Considering the requirements of your employee's current job, how much do you think **the nature of the job** would allow him/her to telecommute							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
11. How much does your employee **currently** telecommute							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
12. How much **would you allow** your employee to telecommute							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
13. Six months from now, how much **do you expect** your employee to be telecommuting							
a. *from a telecommuting center?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7
b. *from home?*	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART F
GENERAL INFORMATION

In this section we ask for some background information about yourself and your organization. Your answers to these questions are important to help us generalize the findings from this small sample to the population as a whole. Again, your responses are strictly confidential.

1. About how many people work for your organization at your regular workplace? (*This workplace may include multiple adjacent buildings occupied by the same organization.*)
   ☐$_1$ 1 - 9 ☐$_2$ 10 - 49 ☐$_3$ 50 - 99 ☐$_4$ 100 - 499 ☐$_5$ 500 or more

2. What is your gender? ☐$_1$ Female ☐$_2$ Male

3. What is your age?
   ☐$_1$ 24 or younger ☐$_3$ 35 - 44 ☐$_5$ 55 - 64
   ☐$_2$ 25 - 34 ☐$_4$ 45 - 54 ☐$_6$ 65 or older

4. How long have you. . .
   a. been a manager? _____ years
   b. worked for this organization? _____ years

5. What is your educational background? (*Check the highest level.*)
   ☐$_1$ Some grade school or high school
   ☐$_2$ High school graduate
   ☐$_3$ Some college or technical school
   ☐$_4$ Four-year college, university, or technical school graduate
   ☐$_5$ Some graduate school
   ☐$_6$ Completed graduate degree(s)

6. How much do you **personally** use a computer on the job?
   ☐$_1$ Not at all
   ☐$_2$ Some (up to several hours a week)
   ☐$_3$ A lot (several hours a day)

COMMENTS: We would value any additional comments you may have. Please write them in the space provided below. Thank you for your time and cooperation!

APPENDIX G

SIGN-IN LOG

APPENDIX G: SIGN-IN LOG

Telecommuting Center Employee Sign-in

DATE (mo./day)	NAME	WORK HOURS AT EACH LOCATION TODAY				HOW DID YOU GET HERE TODAY?						
		Here	Main Office	Home	Other	Walk/ Bike	Alt. Fuel Veh.	Drive Alone	Carpool	Public Transit	Dropped Off	Other
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐
						☐	☐	☐	☐	☐	☐	☐

APPENDIX H

TRAVEL DIARY

TELECOMMUTING CENTERS EVALUATION PROJECT
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, DAVIS, CA 95616-8762
(916) 752-5391

TRAVEL DIARY

OF

_____

(YOUR FULL NAME)

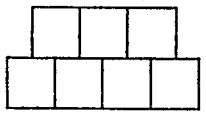
FOR THE DATES OF

_____ __, 19__

_____ __, 19__

and _____ __, 19__
(MONTH) (DAY) (YEAR)

ITS use only



GENERAL GUIDELINES FOR COMPLETING THE TRAVEL DIARY

Thank you for participating in the Telecommuting Centers Evaluation Project.

Please make sure that **each member of your household who is age 16 and** older fills out a travel diary. If your household needs more travel diaries or if you have any other questions about the travel diary, please call the Institute of Transportation Studies (ITS) office at (916) 752-5391. The travel diary is a record of each trip you make in a **consecutive** three-day period. The information that you provide will help us learn more about the travel impacts of telecommuting. Please **fill out your diary as completely and accurately as possible,** preferably **at the time you take each trip.**

In the diary, your travel is broken down into **trip segments.** A **trip segment is defined as travel from one place to another *by any means for any purpose.*** The following are examples of trip segments: a bicycle ride to the park, a drive to work, a walk to the grocery store.

The trickiest part of completing the diary is **making sure each trip segment is recorded** and **assigning an appropriate purpose** to each segment. The examples given below show how to classify your trip segments.

- **On the way home from work, you stop at the dry cleaners to pick up some clothes, then drop by the grocery store for some milk, and finally you drive on home.**

This trip is recorded as **three *separate* trip segments.**

TRIP SEGMENT 1: Drive from work to the dry cleaners.
purpose --*personal business*
TRIP SEGMENT 2: Drive from the dry cleaners to the grocery store.
purpose -- *shopping.*
TRIP SEGMENT 3: Drive from the grocery store to home.
purpose -- *return home.*

EXCEPTION: If the dry cleaners and grocery store were located in the same shopping center **and you walked from one to the other,** then you need not record them as separate trip segments since they are made within the same complex (the shopping center). However, **if you were to start the car again,** it should be **recorded as a separate trip segment.**

The following examples are provided to clarify the **classification of trip segments** and their purposes.

- **A walk to the bus stop followed by a bus ride to work is recorded as two trip segments.**

TRIP SEGMENT 1: Walk from home to the bus stop.
purpose -- *change to other means of travel*
TRIP SEGMENT 2: Bus ride from bus stop to work.
purpose -- *commute to work*

- **Dropping a child off at school and then driving back home is also recorded as two trip segments.**

TRIP SEGMENT 1: Drive from home to school.
purpose -- *drop off passenger*
TRIP SEGMENT 2: Drive from school back to home.
purpose -- *return home*

- **However, if you go for a morning jog or an evening walk for exercise, record just one trip segment** (because the starting and ending point are the same).

TRIP SEGMENT: Walk from home to home.
purpose -- *social / recreation.*

The next page has **step-by-step instructions** on how to fill out the travel diary including the definitions of the purposes of trip segments. Please read the instructions carefully. An **example of a completed diary page** is provided on the following page.

The last seven pages are your diary pages, two for each day of the survey plus an extra page, if needed. If you have any other information that you would like to add, please use the space provided for comments on the inside back cover.

Thanks again for filling out your diary!

STEP-BY-STEP INSTRUCTIONS FOR COMPLETING THE TRAVEL DIARY

BACKGROUND INFORMATION. Please write your ***full name*** on the first page of the travel diary. Check the appropriate boxes that correspond to ***your relationship with project participant, age, gender, and employment status.*** Please enter your ***home, primary work place, and school addresses*** (as applicable).

USE ONE OR TWO DIARY PAGES PER DAY AND ONE LINE FOR EACH TRIP SEGMENT. Please record all the trip segments you make during the selected period of three consecutive days. Always start a new day on a new page. If you make more than 18 trip segments in one day (9 trip segments per page), record the additional segments on the last diary page. ***A trip segment is defined as travel from one place to another, for any purpose and by any means.***

Ⓐ Please enter the ***date*** when the trip segments are made. If you did not make any trips that day, check the box provided.

Ⓑ Circle the appropriate ***day of week*** for that date.

Ⓒ Enter the ***make, model, and year*** of all motor vehicles available to your household. Available vehicles include those that the household owns (or leases) and those provided by an employer. Include information on available ***motorcycles, cars, light duty trucks, and passenger vans.***

Ⓓ Check appropriate box(es) indicating your work location(s) on that day. Check ***"Not working"*** if retired, sick, on vacation, or otherwise not working that day. ***"Other location"*** includes working while traveling, in the field, or at a client's office. ***"Telecenter"*** is short for telecommuting center.

Ⓔ Please enter the address (or the cross streets of the nearest intersection) and the name of city where trip segment **began.** (NOTE: If the trip begins or ends at **home, work, telecommuting center,** or **school,** then the address need not be repeated. Enter "home", "work", "telecenter", or "school", as applicable.)

Ⓕ Please enter the address (or the cross streets of the nearest intersection) and the name of city where trip segment ended. ***The next trip segment should always begin where the preceding segment ended.***

Ⓖ In the given space, enter the ***time of day*** when the trip segment began and when it ended. Check "AM" if morning and "PM" otherwise. Enter noon as 12 a.m. and midnight as 12 p.m.

Ⓗ The purpose of a trip segment is defined by the main activity at the place where your trip segment ends. Please enter the appropriate code (1 through 12) for each ***trip segment purpose*** as indicated in the table located in the ***upper left*** corner of the diary page. The trip segment purpose definitions are given on the Background Information page. ***If a trip segment has more than one purpose, enter the most important one.***

Ⓘ Enter the code (1 through 10) for ***means of travel*** as indicated in the table located in the ***upper right*** corner of the diary page. ***NOTE: Bicycle and walk trips should be included.***

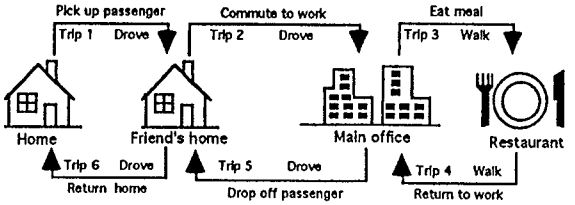
Ⓙ If the ***means of travel code was 1, 2, or 3*** (drove or rode in private vehicle), enter the ***vehicle code*** as shown in Ⓒ and the ***number of people*** in the vehicle ***including yourself.***

Ⓚ If your ***means of travel code was 1, 2, or 3,*** enter the ***starting*** and ***ending odometer readings*** for the trip segment ***(to the nearest 0.1 mile).***

Ⓛ Please enter the ***total distance*** traveled and the ***distance traveled on freeway (to the nearest 0.1 mile).*** If the trip did not involve any freeway miles, enter "0" for that column.

Ⓜ In this column enter any incidental fees including out-of-pocket ***fares*** (bus, rail, other transit, etc.), ***parking charges,*** and ***tolls*** incurred during this trip segment (in dollars and cents). ***Do not include prepaid parking or passes, etc.***

EXAMPLE (see next page for Mr. Smith's completed diary page):
Mr. Smith leaves home in the morning, and on his way to work he picks up a friend. At noon, he walks to a nearby restaurant for lunch and then walks back to his office. At about 5 p.m., Mr. Smith leaves work and drops his friend off on his way back home. In all, he makes six trip segments and fills in 6 lines of his diary page for that day.



BACKGROUND INFORMATION

Your full name: _____

Project participant's full name: _____

Your relationship to project participant:
☐ Self ☐ Spouse / Significant other
☐ Son / Daughter ☐ Other

Your gender:
☐ Female ☐ Male

Your age:
☐ 16-24 years ☐ 45-54 years
☐ 25-34 years ☐ 55-64 years
☐ 35-44 years ☐ 65 and over

Your employment status:
☐ Self-employed ☐ Salaried or Hourly wage
☐ Homemaker ☐ Retired
☐ Student ☐ Unemployed
☐ Other (please specify): _____

Your home address:

_____, _____
(Address or cross streets of nearest intersection) (City)

Your primary work address (if applicable):

_____, _____
(Address or cross streets of nearest intersection) (City)

Your school address (if applicable):

_____, _____
(Address or cross streets of nearest intersection) (City)

TRIP SEGMENT PURPOSE DEFINITIONS

PURPOSE	DEFINITION
COMMUTE TO WORK	The first trip segment of the day made to your primary place of employment or to the telecommuting center.
RETURN HOME	Any trip segment that ends at home; not necessarily the last trip segment of the day.
RETURN TO WORK	All other trip segments after the first that end at your primary place of employment or at the telecommuting center.
WORK-RELATED	Trip segments made to carry out business at places other than the primary place of employment or the telecommuting center (for example, attending business meetings).
DROP OFF / PICK UP PASSENGER	The purpose of the trip segment is to drop off or pick up one or more passengers.
EAT MEAL	A trip segment made to a conventional or fast food restaurant to eat in or take out.
SHOPPING	Trip segments made for the purpose of shopping which includes both window shopping and purchasing goods (groceries, clothes, gasoline, etc.).
SOCIAL / RECREATION	Trip segments made to visit friends, see a movie, attend a sporting event, go camping, and so on.
PERSONAL BUSINESS	This includes trip segments made to carry out personal business (for example, medical / dental appointments).
SCHOOL / EDUCATION	Trip segments made to attend classes as a full-time or part-time student.
CHANGE TO DIFFERENT MEANS OF TRAVEL	Trip segments made for the purpose of changing your means of travel on your way to a final destination (for example, driving to a bus stop to take a bus to work).
OTHER	A trip segment made for purposes not defined above (for example, charitable, political, or religious activities).

Trip segment purposes	
1. Commute to work	7. Shopping
2. Return home	8. Social/recreation
3. Return to work	9. Personal business
4. Work-related	10. School/education
5. Drop off/pick up passenger	11. Change to different means of travel
6. Eat meal	12. Other

Ⓐ TRIPS MADE ON _____ (month / day / year)

☐ Did not make any trips today

Means of travel	
1. Drove conventional motor vehicle	5. Light rail/trolley
2. Rode in conventional motor vehicle	6. BART/Metro Red Line
3. Drove/rode in electric vehicle	7. Commuter train
4. Bus	8. Bicycle
	9. Walk
	10. Other

Ⓑ Day of the week trips made (circle one)

Su Mo Tu We Th Fr Sa

Ⓒ Motor vehicle information (including motorcycles)

Vehicle code	Make	Model	Year
A			
B			
C			
D			

Ⓓ Today I am working from (check all that apply):

☐ Not working ☐ Primary office ☐ Telecenter ☐ Other location ☐ Home

Trip segment	Ⓔ Trip segment began from	Ⓕ Trip segment ended at	Ⓖ Starting and ending time of trip segment		Ⓗ Purpose	Ⓘ Means of travel	Ⓙ Veh. code & No. of people		Ⓚ Odometer reading (nearest 0.1 mile)		Ⓛ Distance traveled (nearest 0.1 mile)		Ⓜ Incidental costs (in dollars and cents)		
Use one line per trip segment	Please indicate: • *Address or cross streets of nearest intersection to where trip segment began* • *City where trip segment began*	Please indicate: • *Address or cross streets of nearest intersection to where trip segment ended* • *City where trip segment ended*	Please indicate: • *Time of day* • *AM or PM*		Enter codes 1 to 12	Enter codes 1 to 10	If you drove or rode in a personal vehicle (*means of travel is 1, 2, or 3*) (see Part Ⓒ)				Please indicate: • *Total distance* • *Distance on freeway*		Please indicate: • *Fares* (bus, rail, etc.) • *Parking charges* • *Tolls*		
			Starting time	*Ending time*	*From above left*	*From above right*	*Veh. code*	*No. of people*	*Beginning*	*Ending*	*Total*	*Freeway*	*Fares*	*Parking*	*Tolls*
1			☐ AM ☐ PM	☐ AM ☐ PM											
2			☐ AM ☐ PM	☐ AM ☐ PM											
3			☐ AM ☐ PM	☐ AM ☐ PM											
4			☐ AM ☐ PM	☐ AM ☐ PM											
5			☐ AM ☐ PM	☐ AM ☐ PM											
6			☐ AM ☐ PM	☐ AM ☐ PM											
7			☐ AM ☐ PM	☐ AM ☐ PM											
8			☐ AM ☐ PM	☐ AM ☐ PM											
9			☐ AM ☐ PM	☐ AM ☐ PM											

APPENDIX I

SAMPLE MEMORANDUM OF UNDERSTANDING

APPENDIX I: SAMPLE MEMORANDUM OF UNDERSTANDING

4/8//94

CHULA VISTA TELECENTER

AGREEMENT BETWEEN THE CITY OF CHULA VISTA AND

_____
Company Name

SCOPE

This Agreement is between the City of Chula Vista (CITY), as operator of the Chula Vista Telecenter and _____, (TENANT) the employer of the telecommuter(s) who will be assigned to the Chula Vista Telecenter for at least one (1) year from this date ___/__/___.

As an instrument of the Chula Vista Telecenter, this Agreement addresses the responsibilities of the CITY and the TENANT regarding the use of the Chula Vista Telecenter. It has no effect on the duties, responsibilities, or conditions of employment between the employer and an employee working at the Telecenter.

COSTS

The majority of what would be "normal" costs for a TENANT (i.e. building and equipment rental fees, utilities) will be underwritten by the Neighborhood Telecenters Program.

The TENANT will be invoiced monthly for costs which are directly related to the work of its employees at the Chula Vista Telecenter. These costs will consist of:

* Telecommunications Charges: These will include all telephone expenses for voice and data communication (i.e. phone, modem, and fax use fees).

* Copy Charges: A copy machine will be on-site for use by the TENANT. The TENANT will be charged for any copies made at the rate of $0.04 per copy.

All invoices will be due in full 30 days from the date of invoice.

CITY reserves the right to change the fee structure for the Telecenter at any time by giving 30 days written notice to TENANT.

SPACE

As a result of this Agreement, TENANT agrees to reserve the following space(s) at the Telecenter:

_____

Reservation of this space will commence on (date) _____

PERSONNEL

TENANT will be responsible for choosing which of its employees will telecommute.

To the extent possible, employees who use the Chula Vista Telecenter will use it a minimum of one (1) day each week. The Tenant will provide to the Telecenter manager a schedule of when each employee will use the Telecenter.

TENANT and employees agree to follow all rules and procedures established by the Telecenter.

TENANT and employees also agree to participate in telecommuter and supervisor orientation and surveys, focus groups, and inquiries conducted as part of the evaluation of the program. Individual response to any material shall remain anonymous, but the data compiled may be made available to the public. Orientation for the telecommuters and their supervisors will be conducted prior to occupancy, if possible. In the event that orientation is not possible, then it will be conducted as soon as is convenient after occupancy.

In the event that unforeseen problems arise, CITY has the absolute right to evict or refuse to admit any telecommuter from the Chula Vista Telecenter for just cause. CITY will not be held responsible for costs, damages or losses resulting from such action.

EQUIPMENT

All equipment, software, or other items provided by the Chula Vista Telecenter will remain the property of the Telecenter (subject to agreements CITY may have with specific providers), and may not be moved, removed or altered in any way without written permission from the CITY.

Telecommuters will use only the equipment at their assigned workstation and that which is provided for general use.

TENANT may choose to use the hardware and software provided by the Telecenter, or provide their own equipment and/or software. If TENANT provides hardware and/or software, this equipment must be used and maintained in a safe condition.

CITY will provide for use by TENANT the following:

- Access to the Chula Vista Telecenter
- Use of workstation, equipped with basic office needs
- Office furniture, as agreed upon by the CITY and TENANT
- Computer hardware and software, as agreed upon by CITY and TENANT
- Telephone
- Access to laser printer
- Access to copy machine
- Access to fax machine
- Use of conference room
- Use of lunch area (with refrigerator and microwave)
- Telecenter management
- Janitorial services
- Building maintenance

TENANT will provide the following for its employees:

Employee supervision
Daily office supplies, e.g. stapler, tape, dispenser, etc.
Any hardware, software, or other equipment or supplies needed by employee that are not already provided at the telecenter

TIME/SECURITY

Normal business hours will be 9:00 a.m. to 5:00 p.m. To the extent possible, the Chula Vista Telecenter manger or another City employee will be available to Telecenter users during these hours.

Access to the Telecenter will be on a 24 hour a day basis. After hours access will be by key or code, as authorized in advance by the Telecenter manager.

CITY will provide all reasonable equipment and policies to ensure the confidentiality of data and documents used at the Telecenter. CITY will not be held responsible for any costs, damages or losses related to use of confidential information at the Telecenter.

LIABILITY/INSURANCE

TENANT agrees to hold CITY, the Chula Vista Telecenter, the program sponsors, and their agents and employees harmless from and against any and all claims, demands, liability (including any related losses, costs, expenses, or attorney's fees) resulting from or arising in connection with any injury or death to persons or damage to property caused directly or indirectly by the services provided hereunder to TENANT'S employees or others, or by their willful misconduct or acts or omissions. TENANT agrees to pay for all damages to the premises and to tenants or occupants thereof caused by TENANT'S misuse of or neglect of the space or any portion of the premises.

CITY will not be responsible for any damage, loss, or theft of equipment or personal belongings of TENANT'S employees or be liable for damage caused by the TENANT'S employees or faulty equipment while they are located in the Chula Vista Telecenter.

Employees who are occupants in the Telecenter must comply with all legal mandates, such as using only legally purchased software, complying with copyright laws, and following proper employment practices such as affirmative action guidelines, workers compensation requirements and federal, state and local laws.

TENANTS agree to carry and maintain during the term of this agreement, comprehensive general liability insurance, including coverage for bodily injury, property damage and personal injury (employee and contractual liability exclusions deleted), with not less than the following limits of liability: One million dollars ($1,000,000) ~~each occurrence~~ combined single limit bodily injury, property damage and personal injury; ~~Two million dollars ($2,000,000) aggregate~~. All such insurance shall be procured from a responsible insurance company authorized to do business in California. Such insurance may be part of any existing or blanket coverage obtained or maintained by TENANT. TENANT will demonstrate proof of required coverage by attaching a copy of a certificate of insurance to this Agreement.

CHANGES TO OR TERMINATION OF THE AGREEMENT

Consent to this Agreement indicates that CITY and TENANT have read and understood this document thoroughly. It is advisable for TENANT to have the Agreement reviewed by legal counsel.

Terms of the Agreement or conditions of use may be terminated or changed by CITY or TENANT with 30 days written notice. This Agreement becomes effective when signed by an authorized representative of CITY and TENANT.

Any changes made and agreed upon between CITY and TENANT will incorporate the needs of the Chula Vista Telecenter in demonstrating telecommuting as a viable work place alternative.

TENANT

_____

Company Name

_____ _____

Authorized Representative Date

( ) Certificate of insurance attached.

CITY OF CHULA VISTA

_____ _____

Barbara Bamberger, Environmental Resources Manager Date