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The Costs and Benefits of Telecommuting: A Review and Evaluation of Micro-Scale Studies and Promotional Literature

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THE COSTS AND BENEFITS OF TELECOMMUTING: A REVIEW AND EVALUATION OF MICRO-SCALE STUDIES AND PROMOTIONAL LITERATURE

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THE COSTS AND BENEFITS OF TELECOMMUTING: A REVIEW AND EVALUATION OF MICRO-SCALE STUDIES AND PROMOTIONAL LITERATURE

Abstract

This literature review has been prepared to synthesize and assess previous small-scale economic evaluations of telecommuting. These small-scale studies can be categorized as telecommuting pilot projects that take into account telecommuter and employer costs and benefits. (The reader is referred to a 1998 review of macro-scale telecommuting literature by Shafizadeh *et al*.). In this report, four studies are selected and examined as representing the state of practice regarding methodology and assumptions. The report identifies common inputs, critical assumptions, and limitations of these works. Finally, the major findings of each study are presented and compared to claims found in promotional literature. Among the primary findings of this review is the conclusion that few pilot evaluations contained cost-benefit results. Nonetheless, the results that are available supplement the macro-scale studies and furnish a variety of empirical values that are essential in complete cost-benefit analyses.

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EXECUTIVE SUMMARY

The purpose of this study is to assess the methodologies, assumptions, and results of economic evaluations of telecommuting presented in reports on "small-scale" pilot demonstration programs. This paper follows an earlier report that focused on public sector, *macro-scale* studies (Shafizadeh *et al.*, 1998). As noted in the earlier report, both small- and large-scale perspectives are important to making a full economic assessment of telecommuting. Micro-scale studies focus on the costs and benefits at the individual and organizational level; macro-scale studies typically focus on estimating the aggregate costs and benefits for regional or national populations of telecommuters.

The four micro-scale studies examined in this report provide information on the *individual* costs and benefits of telecommuting using empirical data (most often from employee surveys) that cannot be obtained from macro-scale studies, which are largely hypothetical in nature. This study shows that the early evaluations did not focus on the *economics* of telecommuting but instead on the *feasibility* and *desirability* of telecommuting from the employer's and/or the telecommuter's perspective. Key costs and benefits are often acknowledged but not fully quantified. The goal of this report is to extract and abridge the empirical results from the micro-scale studies that remain valuable in assessing the costs and benefits of telecommuting. Among the primary findings is the conclusion that few pilot evaluations contained cost-benefit results. More importantly, these reports furnish a variety of empirical values that can be used in cost-benefit analysis estimates.

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1.0. INTRODUCTION

The purpose of this report is to assess the methodologies, assumptions, and results of economic evaluations of telecommuting presented in reports on "small-scale" pilot demonstration programs. This study follows an earlier report that focused on public sector, *macro-scale* studies (Shafizadeh *et al.*, 1998). As noted in the earlier report, both small- and large-scale perspectives are important to making a full economic assessment of telecommuting. Micro-scale studies focus on costs and benefits at the individual and organizational levels; macro-scale studies typically focus on estimating the aggregate costs and/or benefits for regional or national populations of telecommuters. The micro-scale studies examined in this report provide information on the *individual* costs and benefits of telecommuting using empirical data (most often from surveys of employees) that cannot be obtained from macro-scale studies, which are largely hypothetical in nature.

One of the primary goals of this report is to evaluate the micro-scale studies in the telecommuting literature. It will be shown that the focus of past telecommuting evaluations has not been on the *economics* of telecommuting but instead on the *feasibility* and *desirability* of telecommuting from the employer's and/or the telecommuter's perspective (e.g. "work social impacts" (JALA Associates, 1990, p. 44)). The evaluation will also reveal that key costs and benefits were often acknowledged but not fully quantified.

The second primary goal of this report is to extract the empirical results from the micro-scale studies that remain valuable in assessing the costs and benefits of telecommuting. Few studies, if any, have attempted to consolidate or compare past economic evaluations of telecommuting with other fragments of information dispersed throughout the literature.

Ultimately, this report will contribute to the current body of knowledge by providing a condensed list of cost-benefit values from a variety of sources and by acknowledging specific aspects of the micro-scale cost-benefit analysis that remain difficult to quantify.

Each of the four studies that were evaluated in this report were of public sector pilot projects – meaning that they were telecommuting trial studies conducted specifically for exploratory and evaluation purposes. While it is noteworthy that various levels of the public sector (city, county, regional, and state) are represented by these studies, it is more important to note that these studies were selected because they contain cost-benefit results for employers and employees based on data collected from actual telecommuting demonstration projects.[1] The studies are:

- *Evaluation Report: Telecommuting Pilot Project for the Southern California Association of Governments* (Southern California Association of Governments, 1988)[2];
- *County of San Diego Dept. of Public Works, Telecommuting Prototype Program, Telecommuting Pilot Study Final Report* (County of San Diego Department of Public Works, 1990);
- *State of California Telecommuting Pilot Project Final Report* (JALA Associates, 1990); and
- *City of Los Angeles Telecommuting Project* (JALA International, 1993).

[1] Only public-sector studies were used in this study because there are few private-sector studies available to the general public that contain detailed cost-benefit data.

[2] The lead author of the SCAG report is the second author of this report. Patricia L. Mokhtarian evaluated the SCAG pilot while employed at SCAG and while serving as chair of the Central City Association Telecommuting Task Force.

Although we reviewed many other reports evaluating telecommuting demonstration projects, it was quite surprising to discover that only these four studies had collected and reported detailed monetized cost-benefit results – often along with results from attitudinal data collection. Some of the other reports we reviewed contained one or two relevant results, and are cited in the section titled "Other Micro-Scale Values." Many reports focused on evaluating attitudes toward telecommuting. While these data provide useful insight into the perceived desirability of telecommuting, they have little to offer in terms of the microeconomics of telecommuting, which is the subject of this report. A list of studies which were reviewed for this report, but which did not prove germane to the cost-benefit analysis, is provided in the appendix.

Evaluation Report: Telecommuting Pilot Project for the Southern California Association of Governments (SCAG, 1988)

In 1988, the Southern California Association of Governments (SCAG), in conjunction with the Central City Association Telecommuting Task Force, conducted an evaluation of telecommuting among SCAG employees. The main objective of this pilot project was to "obtain firsthand experience with the benefits, disadvantages and other issues associated with telecommuting." A secondary objective was to "assess the direct and indirect costs and benefits of the pilot" (SCAG, 1988, p. I-9). Although the SCAG study involved only 18 employees (14% of the total) and lasted only six months, it seems to be among the first publicly available evaluations of telecommuting in the United States.

County of San Diego Dept. of Public Works, Telecommuting Prototype Program, Telecommuting Pilot Study Final Report (County of San Diego Dept. of Public Works, 1990)

At the request of its Board of Supervisors in 1990, the County of San Diego conducted an evaluation "to investigate the feasibility of establishing a telecommuter program for County employees" (CSD, 1990, p. 1). The Department of Public Works was selected to conduct the pilot project under the guidance of the Telecommuting Task Force. This pilot project was extremely short (four months) and did not have many participating telecommuters (only 14), but contains some useful cost-benefit data, particularly with respect to the individual telecommuter.

State of California Telecommuting Pilot Project Final Report (JALA Associates, 1990)

Funded by the State of California Department of General Services, the major objectives of the California Telecommuting Pilot Project were to evaluate the feasibility and document the viability of telecommuting by state employees. The goals were not only to assess the impact of telecommuting on the "effective delivery" of state services, but also to determine the impact that telecommuting would have on productivity output, such as quality of work. Furthermore, the pilot project had a series of secondary objectives, such as determining the possibility of making new state services accessible by telecommuting and the opportunities telecommuting offered for the employment of persons with disabilities. The implementation phase of the State of California study included 150 participants from 14 State agencies and lasted two years. Almost two years of planning and preparation took place before telecommuting was actually implemented.

City of Los Angeles Telecommuting Project (JALA International, 1993)

The last micro-scale study included in this literature review was completed for the City of Los Angeles Department of Telecommunications in 1993. This project shares many similarities with the California Telecommuting Pilot Project, including the primary author (consultant Jack Nilles) and methodology (as will be discussed in the next chapter). The goal of this study was to investigate many of the benefits assumed to be associated with telecommuting, including reduction of air pollution, traffic congestion, energy dependency, office space requirements, parking space requirements, increased employee productivity, personnel retention, and job accessibility by the mobility disadvantaged. It involved as many as 426 telecommuters.

A summary of each of the data collection methodologies is presented and compared in Chapter 2. In this chapter, we also point out major assumptions and constraints of each study. In the third chapter, we present some key results from each of the four studies, and we compare these results with values seen in other publications and in promotional brochures. This chapter also contains a discussion of the difficulty in estimating certain key factors in economic evaluations of telecommuting, and touches on some of the proprietary software packages that are available to make micro-economic evaluations of telecommuting. The final chapter summarizes and comments on the main findings of this study.

2.0. METHODOLOGY, CONSTRAINTS, AND ASSUMPTIONS

In this chapter, we briefly discuss and compare the empirical settings and methodologies used in each of the projects. In general, all four projects shared similar goals and objectives, data collection tools, and constraints. It will be shown that the larger sample sizes and longer study periods (and larger budgets) of the two JALA projects allowed for more elaborate and convincing evaluations than did either the SCAG or San Diego projects, although the latter two still provided information not available in the former two.

Despite their similarities, there are certain important factors that distinguish these studies from each other. Moreover, these distinguishing factors affect the conclusions that can be drawn from the data. In particular, an evaluation of project goals and planning might help to explain some of the initial differences in results. Additionally, the project sample size, the project duration, and the observed telecommuting frequency will cast some doubt on the "generalizability" of some results. Furthermore, the use of a control group during the project will have an impact on the conclusions that can be drawn from the data. Finally, it will be shown that certain project stipulations and guidelines (e.g. the bearer of equipment costs) will impact the results. Above all, the following sections are important in evaluating and comparing the validity of results: the quality of the data collection methodology should be an important consideration in the use of a result in other cost-benefit analyses.

2.1. Study Goals and Objectives

From Table 1, we can see that the primary goal of each of these studies was essentially to evaluate the attitudes and perceptions of telecommuters and to summarize the advantages and disadvantages of telecommuting – not necessarily to develop a business case of costs and benefits. The study goals and objectives are broadly written such that many aspects of telecommuting could be investigated. For example, the SCAG report's goal was to investigate "benefits, disadvantages, and other issues associated with telecommuting" (SCAG, 1988, p. I-9). As a result, a wide range of issues was often addressed – with costs and benefits comprising only a small part of the final results.

Table 1. Comparison of Study Goals and Planning

Study	**SCAG (SCAG, 1988)**	**County of San Diego (CSD, 1990)**	**State of California (JALA Associates, 1990)**	**City of Los Angeles (JALA International, 1993)**
Sponsors	SCAG, Central City Association Telecom-munications Task Force	Board of Supervisors, Chief Admin. Office, Telecommuting Task Force, Dept. of Public Works	State of California Department of General Services	City of Los Angeles Department of Telecom-munications
Primary Goal	To document "benefits, disadvantages, and other issues associated with telecommuting" (p. I-9)	"To investigate the feasibility of establishing a telecommuting program for County employees." (p. 1)	To assess "the impact of telecommuting on … existing State services" (p. 11) (See Table 2.)	To test if "preliminary cost benefit forecasts point to substantial advantages of telecommuting" (p. 3)
Implement-ation Plan?	Yes (January 1986)	No	Yes (June 1985)	Yes (August 1989)
Telecom-muting Type	Primarily home-based (1 center-based)	Home-based only	Home-based only	Home-based only

The goal of the County of San Diego demonstration was "to investigate the feasibility of establishing a telecommuting program for County employees" (CSD, 1990, p. 1). As a result, its key findings consisted of perceived attitudinal changes in management and social issues (e.g. individual productivity, morale, and motivation, and stress). Costs and benefits were addressed in this small study, although they were not the main focus in determining the feasibility of telecommuting.

The State of California report had a broad list of nine explicit objectives, as shown in Table 2. Ironically, while the collection or evaluation of costs and benefits was not mentioned among the objectives, substantial cost-benefit data are available in the study results.

Table 2. State of California Study Objectives

1. To assess the impact of telecommuting on the effective delivery of existing State services;
2. To determine the consequences of telecommuting for managers and employees of state agencies, including quality of life within state agencies;
3. To explore the possibility of new state services made possible by telecommuting;
4. To evaluate the opportunities created by telecommuting for the employment of, and enhancement of working life for, persons with disabilities;
5. To test a results-oriented management approach as a key tool for successful telecommuting;
6. To develop improved tools for selecting, training, and evaluating telecommuters and supervisors of telecommuters;
7. To estimate the impact of telecommuting on reducing traffic congestion, air pollution, and energy use;
8. To develop guidelines for expanding telecommuting generally within state government, and;
9. To develop and test ways of equitably sharing office space and reducing total space requirements.

Source: JALA Associates, 1990, p. 11.

Unlike the State of California, the City of Los Angeles study specifically attempted to test claims of "substantial savings" in its cost-benefit forecasts. Additionally, the study sought to "actively explore" the impacts of telecommuting on: air pollution, cost-effectiveness, traffic

congestion, energy dependency, office space, attracting/retaining personnel, and access to jobs (JALA International, 1993, pp. 2-3).

2.2. Empirical Setting and Data Collection

As Table 3 indicates, a variety of data collection tools were involved in these telecommuting evaluations. In general, we can see that the SCAG and County of San Diego studies relied on a greater number of data collection tools than the JALA studies. It appears that similar information was acquired, however, because the JALA surveys grew in length and depth to encompass some of the other data collection instruments. For example, travel and cost information were eventually integrated into the telecommuter surveys in the City of Los Angeles study to avoid requiring the administration of separate travel logs and/or expense logs.

Table 3. Comparison of Study Evaluation Tools

Data Collection Tool	SCAG (SCAG, 1988)	County of San Diego (CSD, 1990)	State of California (JALA Associates, 1990)	City of Los Angeles (JALA International, 1993)
Telecommuter questionnaires	✓	✓	✓	✓
Supervisor questionnaires	-	✓	✓	✓
Travel log	✓	✓	✓	-
Personal conversations	✓	✓	✓	✓
External data	✓	-	✓	-
Group meetings or discussions	✓	✓	-	-
Timesheets	✓	-	-	-
Receptionist logs	✓	-	-	-
Telephone interviews	-	✓	-	-
Telecommuting/ Expense logs	✓	✓	-	-

Self-completed telecommuter questionnaires were used frequently throughout the planning and implementation of all four pilots. "Selection surveys" were part of the initial screening process to identify "employees most likely to be successful in telecommuting" (SCAG, 1988, p. III-1). According to the County of San Diego study, the purpose of the "Employee Character Assessment" screening process was to: "evaluate whether the candidate is a self-starter, is able to produce … a measurable work product, demonstrates exceptional work or project commitment, and recognizes that telecommuting is a 'privilege not a right'" (CSD, 1990, p. 5). Additional self-administered telecommuter questionnaires were distributed before and after each study period to capture changes in attitudes and perceptions. Midterm evaluations were also requested in the two JALA studies. While a practical and to some extent unavoidable means of collecting data, self-reports may contain biases stemming from a telecommuter's personal motivation to encourage the development and support of telecommuting beyond the trial phase.

After telecommuters were chosen, a "before-wave" survey was given to telecommuters and managers to assess a wide range of issues and activities related to telecommuting, such as preliminary attitudes toward "work-related as well as personal impacts of telecommuting (e.g. on productivity, on communication, on family)" (SCAG, 1988, p. III-1). These before-wave survey responses were later compared to "after-wave" survey responses to quantify changes in perceptions as a result of the telecommuting pilot project. While offering important insight into the perceived advantages and disadvantages of telecommuting, these quantified changes in perception have limited utility in monetizing costs and benefits.

Along with the before and after surveys, SCAG, the County of San Diego, and the State of California used other data tools such as travel logs. The City of Los Angeles integrated

additional data tools into lengthy questionnaires so that similar information was collected by all four studies. In all cases, travel information was obtained and informal group discussions and personal conversations were conducted during the pilot. Most often, the informal interviews were used in "surfacing operational problems and developing approaches to their solution" (JALA Associates, 1990, p. 46). The only other notable data collection tool was a monthly telecommuter log – used by both SCAG and the County of San Diego – in which employees documented the majority of their directly financial telecommuting-related costs and benefits, such as:

- work-related telephone time and costs,
- communication and equipment costs,
- miscellaneous costs or savings (e.g. travel, supplies, food, etc.),
- additional energy consumption, and
- changes in trip generation.

2.3. Control Groups

Among the most notable distinctions of the JALA methodology was the inclusion of a non-telecommuting control group in the evaluation.[3] In general, the control group allowed the analysts to distinguish changes in behavior due to telecommuting from other changes in employee behavior that might be occurring at the same time. The addition of a control group, combined with larger sample sizes, allowed for potentially statistically significant conclusions to be drawn from changes in telecommuter behavior over the course of the study. With the SCAG and San Diego studies, one cannot be certain that changes in employee behavior were due to

[3] It appears that the control groups were selected from the original groups of prospective telecommuters; hence, they may not be completely representative of comparable non-telecommuting workers.

telecommuting alone, or if there were other contributing factors. However, for the present purpose of analyzing costs and benefits clearly attributable to telecommuting, this drawback is less important.

Table 4. Comparison of Study Characteristics

Study	SCAG (SCAG, 1988)	County of San Diego (CSD, 1990)	State of California (JALA Associates, 1990)	City of Los Angeles (JALA International, 1993)
Duration[4]	13 months	4 months	42 months	40 months
Sample Size (employees)	18 telecommuters	14 telecommuters	107 telecommuters and 141 controls[5]	426 to 156 telecommuters
Telecomm. Frequency	10% to 60%	20%	17% to 22%	13% to 18%
Control Group	No	No	Yes	Yes
Bearer of Equipment/ Phone Costs	Employer and Employee (shared)	Employee	Employer	Employer

2.3. Sample Size

As shown in **Table 4**, the SCAG results are based on (at most) 18 telecommuters, and the County of San Diego results are based on only 14 telecommuters. In contrast, the State of California and City of Los Angeles results are based on more than 150 telecommuters. Findings based on average values from small samples may not be generalizable because they are more susceptible to outliers that may provide misleading results (Neter *et al.*, 1996). For example, the average commute distance might be misleading if one telecommuter in a group of ten commuted 200 miles per day, when the other nine telecommuters commuted 15 miles per day. This outlier

[4] Study duration typically includes at least four stages: planning, pre-implementation, implementation, and evaluation.
[5] As shown in Table 7 of the reference. Different numbers are reported in other tables of the reference, due to attrition and non-response.

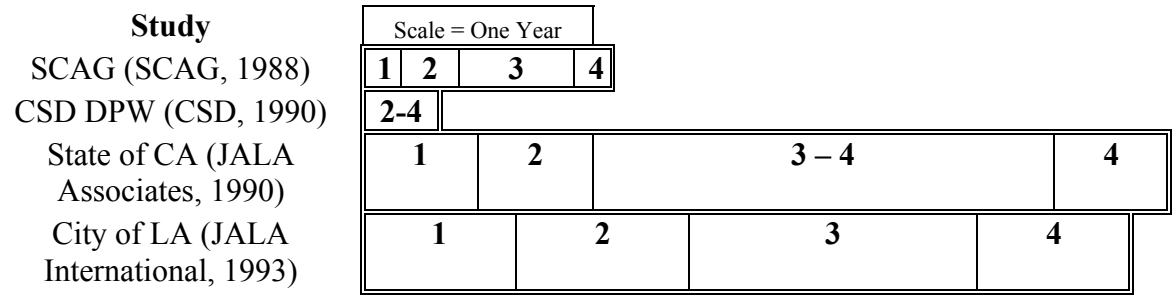
would not have the same impact on the overall average commute distance if the sample contained 50 telecommuters instead of ten.

Telecommuter attrition is also an important issue and could have an impact on the results. The City of Los Angeles had 426 telecommuters at the beginning of its project, but only 156 at the end; this represents a loss of 63% of the original sample size. Although rigorous data on attrition are scarce (Varma *et al.*, 1998), this rate does not appear to be exceptional. One implication is that reported results might apply only to those who stay in the program, not to the short-term telecommuters comprising the majority of participants in most programs.

2.4. Study Duration

Study duration will also play a role in the conclusions that can be drawn from the data. Data collected during short implementation periods could be inaccurate if the observed behavior is still unstable. For example, a study with a short duration could show high levels of telecommuting frequency and might not reveal a change in telecommuting frequency or in the number of telecommuters. A longer study period, however, is more likely to have reached an equilibrium point at which more consistent assessments can be made of telecommuting behavior. Ideally, the study duration should be long enough so that attrition and entry rates have stabilized (at values that are not necessarily equal to each other). While both JALA projects allowed for telecommuter "turnover" to occur throughout the implementation phases, the County of San Diego project appeared to have a small and static telecommuting population for the relatively short study. As a result, the results from the County of San Diego report may be considered to be the least reliable.

Timelines from each of the four studies are compared in Figure 1. It can be seen that some studies were less elaborate than others were and did not have a period for planning or pre-testing before the actual data collection period. While this may not be a problem *per se*, it is likely that a project with planning and pre-implementation phases would have better study methodology and would have fewer problems with potential sources of bias or error.



Key: 1 = Planning Stage, 2= Pre-Implementation Stage, 3 = Implementation Stage, 4 = Evaluation Stage

Figure 1. Comparison of Study Timelines

The County of San Diego pilot project does not appear to have a planning or pre-implementation stage – although the details are not clear. The project was proposed by the County of San Diego Board of Supervisors on January 9, 1990, and the pilot began on February 13, 1990. The executive summary indicates that the pilot implementation occurred over a four-month period, and the final evaluation report was completed on June 19, 1990 – almost exactly four months after the project began. So, there was little if any time for planning or pre-implementation. However, the final report states that participants were "carefully screened volunteers" (executive summary, CSD, 1990) and that telecommuting screening surveys and before-wave attitudinal surveys were administered.

In comparison, we see that every stage of the State of California and the City of Los Angeles projects was longer than each corresponding stage in the SCAG pilot. The planning process alone for State of California and the City of Los Angeles projects took more than six

months. This longer process correlate with the more extensive methodologies and results associated with these two projects.

2.5. Rules, Restrictions, and Guidelines

When looking at the empirical setting, it is important to analyze the project "ground rules" that were set forth prior to the implementation of each pilot project. These constraints directly affect the resulting costs and benefits of each study. In this section, it will be shown that certain organizational policies limited the costs that the organization would bear for telecommuting-related expenses. In general, these guidelines helped to minimize employer costs and to emphasize that telecommuting is merely an "alternate method of meeting the needs of the agency" (ES-4, SCAG, 1988). Moreover, they demonstrate how an organization can minimize costs, yet still make telecommuting available to a select group of employees.

As one example of rules affecting results, SCAG agreed to pay for only 60% of all work-related telephone calls during its study. At the same time, SCAG elected not to bear the costs of any additional office furniture or communications services (e.g. call waiting, second phone lines, personal computers, modems, printers, etc.) for the telecommuter. In general, any additional expenses were approved on a case-by-case basis. On a case-by-case basis, SCAG agreed to partially reimburse employees for additional one-time communication installation costs, however, reimbursement would only be proportional to the amount of time telecommuted (e.g. "one day a week telecommuting gets $1/7^{th}$ of the bill reimbursed" (SCAG, 1988, p. A-2)). To minimize outside costs, SCAG also declined to reimburse employees for supplies normally available at SCAG (e.g. paper, computer disks, etc.). Further, SCAG reserved the right to terminate any telecommuting arrangement.

The County of San Diego, like SCAG, had a policy that required employees to purchase their own equipment if necessary. According to the San Diego report, some telecommuters voluntarily purchased equipment (computers) for home and office use, however it does not appear that purchases were reimbursed as a result of their policy:

> "To purchase and issue required telecommuting equipment, … there would have to be either changes to existing Administrative Manual Procedures pertaining to the personal assignment and control of County fixed assets or the development of new procedures to deal with this issue specifically" (p. 16).

Instead of reimbursement, the Department of Public Works simply provided "information on product discounts" (CSD, 1990, p. 19). As a result of this policy, telecommuters used their personal equipment, and some charged the County for the use of their personal computer while telecommuting.[6] In its assessment of this situation, the County of San Diego study acknowledged that some of its guidelines "could require Board policy and County Administrative procedure changes" given a permanent telecommuting policy (CSD, 1990, p. i). In other words, the study implies that policy should be changed so that telecommuters can get reimbursed for their work-related costs.

In the State of California project, specific constraints were not as confining as in the SCAG or County of San Diego programs. In fact, it does not appear that equipment and communication cost guidelines were defined prior to the pilot. Constraints may not have been defined because it was assumed that "most of the telecommuters would have personal computers for use," but the study later found that "these assumptions have proven to be invalid" (JALA Associates, 1990, p. 35).[7] Consequently, frequent telecommuters often took their State-provided computers home to work, and "few, if any, agencies were required to make unplanned

[6] Two telecommuters tallied $17.86 and $71.43 in "incremental indirect costs" due to "computer usage" (p. 57).
[7] As a result of the pilot, the final report recommended that telecommuting "technology needs" be established.

expenditures for computers or other telecommuting-specific technology" (JALA Associates, 1990, p. 3).

The City of Los Angeles project referred to a set of guidelines that was offered to all departments participating in the program, but these guidelines were not included in the final report, nor was the level of compliance with these guidelines specified. However, a revised set of recommended guidelines was presented as Appendix 1 of the report. These included suggestions such as, "all necessary equipment and equipment maintenance costs should be covered by the City in all cases where the telecommuter needs the equipment for telecommuting" (JALA International, 1993, p. 72), and "all operating costs of telecommuting . . . shall be paid for directly or reimbursed to the telecommuter by the City" (JALA International, 1993, p. 72).

3.0. DISCUSSION AND ANALYSIS OF STUDY RESULTS

This chapter contains a comparison and discussion of monetized results found in each of the micro-scale pilot projects. First, however, we simply compare the cost-benefit information that is contained in these studies. As was noted in the previous chapter, all four pilot projects used similar data collection tools, and Table 5 indicates considerable uniformity in the costs that were explored. However, Table 6 indicates considerable diversity in the benefit factors addressed. These tables contrast with similar comparisons in macro-scale studies where the majority of results focus on the benefits of telecommuting. (The reader is encouraged to compare a similar table in Shafizadeh, *et al.,* 1998).

Table 5. Cost Factors Examined

Study	SCAG (SCAG, 1988)	County of San Diego (CSD, 1990)	State of California (JALA Associates, 1990)	City of Los Angeles (JALA International, 1993)
Employer				
Telecom Equipment	●	●	⊗	●
Telecom Software	⊗	●	⊗	●
Telecom Services	●	●	●	●
Telecom Maintenance	⊗	●	●	●
Training	▌	●	●	⊗
Employee				
Utilities	◗	●	●	⊗
Misc. Costs	●	●	●	●

KEY: ● Monetized | ◗ Quantified but Not Monetized
▌ Mentioned, but Not Quantified | ⊗ Not Mentioned

In Table 6, we see that employer-side benefits were not the focus of either the SCAG or the City of Los Angeles reports. Also surprising is the difference between the two JALA studies – almost all results are monetized in the State of California evaluation, while few results are monetized in the later City of Los Angeles report. Additionally, we see that in both JALA studies, telecommuter-side benefits were either not included or not quantified. The SCAG and County of San Diego studies were the only ones that meaningfully addressed telecommuter benefits.

Table 6. Benefit Factors Examined

Study	SCAG (SCAG, 1988)	County of San Diego (CSD, 1990)	State of California (JALA Associates, 1990)	City of Los Angeles (JALA International, 1993)
Employer				
Work Productivity	▮	◗	●	▮
Reduced Absenteeism	⊗	⊗	●	▮
Parking Space Benefits	⊗	⊗	●	▮
Office Space Benefits	⊗	●	●	▮
Recruitment/Retention	▮	▮	▮	▮
Employee				
Commute Cost Savings	●	●	⊗	▮
Misc. User Benefits	●	●	⊗	▮

KEY: ● Monetized | ◗ Quantified but Not Monetized
▮ Mentioned, but Not Quantified | ⊗ Not Mentioned

3.1. Monetized Results

The monetized micro-scale results are synthesized in this section and presented for comparison in Table 7. Whenever possible, we averaged the results over the total number of telecommuters to present results on a per-telecommuter-per-year basis (e.g. average communications *cost per telecommuter per year*). By averaging the results over the total number of telecommuters, we hope to maintain some consistency among results so that they can be

compared. Whenever possible, the appropriate number of telecommuters associated with a result is noted, especially when the result is due to only one or two telecommuters.

Some of the SCAG results remain in terms of *dollars per telecommute event* or *dollars per telecommute occasion*.[8] It was not possible to convert these *per-occasion* costs and benefits into annual costs and benefits without making some of our own assumptions because the number of telecommute occasions was not available in the SCAG report. As an approximation, we assumed an average telecommuting frequency of 1.2 days/week and an average work year of 236 days so that the SCAG results could be converted into a *per capita per year* basis, which are shown in parentheses in Table 7 and Table 8.[9]

According to the County of San Diego report, the training cost for its 14 telecommuters and managers totaled $1,743. This cost comprises four distinct components: orientation of telecommuters ($532), orientation of supervisors ($432), focus groups ($247), and surveys ($532). Senior managers and executives spent one hour in a general orientation "focused on [understanding] telecommuting as a management tool" (CSD, 1990, p. 5) at a cost of $432. An additional $532 was spent for one hour of telecommuter and one hour of supervisor training ($38 per each supervisor-telecommuter pair). Along with training, it appears that an additional $247 and $532 were spent on training-related focus groups and surveys, respectively. The training cost for each telecommuter-supervisor pair ($38) in this study is considerably lower than the

[8] The SCAG researchers recognized that each telecommuter might exhibit a different frequency and that the results from each telecommuter should be weighted by the corresponding number of telecommuting occasions. Understandably, the telecommuter who foregoes travel three days per week will have a greater average benefit than the telecommuter who foregoes travel only one day per week, but should have comparable benefits per telecommute occasion.

[9] The value of 236 is obtained by assuming 365 days per year, less 104 weekend days, 10 federal holidays, and 15 vacation days. Combined with an average telecommuting frequency of 1.2 days per week, these assumptions translate into the single assumption that there are approximately 57 telecommute occasions per year, on average.

$300 per telecommuter-supervisor pair training cost projected by the State of California study program consultant.

The SCAG and County of San Diego studies are also distinct from the other two (but not unusual in the authors' experience) because most employees used their own equipment in the study and assumed the majority of the startup costs. In the SCAG study, all except two employees used their own telecommuting equipment (i.e. computers), while all employees used their own equipment in the County of San Diego study. Employer costs remain, however, because one computer was provided by SCAG for a user who did not own one – at a cost of $2,691. In general, it would be reasonable to expect the price of a complete desktop computer to be between $1,500 and $3,000 (as the cost for the same computing speed and processing power certainly continues to decline over time).

Table 7 summarizes and compares the costs in the micro-scale studies. It is important to point out that these costs were averaged over all telecommuters, not just the telecommuters incurring each type of cost, to remain consistent with the SCAG estimates (which were only provided in terms of average costs). This reflects the reality that not every telecommuter will incur every cost. However, the average cost *per person incurring that type of cost* could be used to represent a "worst case" scenario. In other words, for example, equipment could be expected to cost as much as $2,700 per telecommuter if all computer expenses were borne by the employer.

Table 7. Comparison of Estimated Telecommuting Costs

Cost	SCAG (SCAG, 1988)	County of San Diego (CSD, 1990)	State of California (JALA Associates, 1990)	City of Los Angeles (JALA International, 1993)
Training*	N/A	$68.86[a]	$300[b]	N/A
Equipment*	$149.50[c]	N/A	N/A	$1,108[k]
Software	N/A	$17.50[d]	N/A	$210[k]
Phone Installation*	$4.72[e]	$12.93[f]	N/A	N/A
Phone Services (Telecommunications)	$0.17 per occasion (~$9.67 per year)[g]	$12.86[i]	$360	$15[k]
Work-Related Travel	$0.02 per occasion (~$1.11 per year)[g]	N/A	N/A	N/A
Equip. Maintenance	N/A	N/A	$25[j]	$47[k]
Furniture*	$12.50[h]	N/A	(negligible)	$157[k]
Insurance	N/A	N/A	(negligible)	N/A
Additional Costs	N/A	$18.29	$131	$219[k]

Notes: All results are per telecommuter per year, except for start-up costs, denoted by an asterisk (*), which are per telecommuter. "N/A" indicates that the result was not available, which may or may not mean the cost was zero.
a. The cost of training includes the total cost of telecommuter and supervisor orientations divided by the total number of telecommuters. Focus group and survey costs were not included here.
b. The cost of training was projected and was not directly measured in the State of California study.
c. The cost of equipment in the SCAG study was limited to the purchase of a computer for one telecommuter at a cost of $2,691. Averaged over all telecommuters, we obtain an average equipment cost of $149.50 per telecommuter for all 18 telecommuters.
d. The software cost in the San Diego study represents the purchase of WordPerfect 5.0 software by one telecommuter at a cost of $245. No other software was provided. Averaged over all 14 telecommuters, we obtain software cost of $17.50 per telecommuter.
e. SCAG installed a phone line for one employee at a total cost of $85.
f. The phone installation costs in the County of San Diego study stem from installation charges totaling $181 for two telecommuters.
g. Participants indicated incurring additional costs in these categories that they did not report for reimbursement because they were too small.
h. SCAG purchased home office furniture for one employee at a total cost of $225.
i. One telecommuter was reimbursed for the monthly cost of $15 for a second phone line; this amount is averaged over all 14 participants.
j. JALA estimated $250 per year per state-supplied computer; with those being a "small fraction" of the total.
k. These costs were reported by 96 (62%) of the 156 telecommuters responding to the survey, and averaged over all 156.

The other major cost most commonly at issue is that of telecommunications (typically telephone). The City of Los Angeles and State of California reports noted that although "telephone bills are considered to be the largest operational cost element for telecommuting"

(JALA International, 1993, p. 16), it is "difficult to assess the extra operating costs of telecommuting," because "estimates of phone charges attributable to telecommuting are not always clear" (JALA Associates, 1990, p. 34). Of particular concern is the "absence of methods … used to account for telephone services" (JALA Associates, 1990, p. 34). Because telecommuting does not always require a separate phone line, it can be difficult to isolate telecommuting calls from non-telecommuting calls.

In these four studies, only the State of California did not assume any installation and operating costs of an additional phone line. Instead, the State of California found that a telecommuter spends $9.43 per month ($113.16 per year), on average, more on telephone calls than a non-telecommuter, and made a conservative adjustment to $30 per month ($360 per year) to account for additional telecommuter phone calls. For the installation of an additional phone line, SCAG incurred an additional cost of $85 for one telecommuter out of 18, and the County of San Diego incurred a cost of $181 for two telecommuters out of 14.

The County of San Diego estimated the monthly service charges at $15, but only paid this cost for one telecommuter. SCAG telecommuters reported only spending $0.17 per telecommute occasion (~$9.67 per year). It appears that the SCAG value only takes into account actual phone call charges from an existing line and does not involve additional monthly service charges. Hence, it may represent a best case scenario in which a separate phone line is not required.

In general, it remains important to distinguish those services that are exclusive to telecommuting (e.g. a second, dedicated phone line) and those services that are part of regular household activities (a shared phone line). Moreover, telecommunications service requirements should be researched because it is considered one of the largest telecommuting operating costs (JALA Associates, 1990). In terms of other start-up expenses, furniture was provided by SCAG

for one individual at a cost of $225 to the employer. This contrasts with the State of California where it was assumed that the costs for furniture, insurance, office space, and reduced parking are negligible.

Along with equipment purchasing costs, we would expect equipment maintenance as well as software costs. The City of Los Angeles study included initial software costs with an average of $210 per telecommuter, while the County of San Diego study had only one telecommuter purchase software at a cost of $245. Both JALA studies included annual equipment maintenance costs, with similar estimates from the City of Los Angeles ($47 per telecommuter per year) and the State of California ($25 per telecommuter per year).

From this section, we see that the pilot projects provide critical but limited empirical data. Because these studies were not focusing on the "business case" for telecommuting, the majority of telecommuter costs and benefits remain unquantified. The direct quantified telecommuter benefits are shown below in Table 8 and are limited to SCAG and County of San Diego estimates of travel cost savings and miscellaneous cost savings (e.g., food, cleaning, etc.). Other benefits included by the State of California (i.e., increased productivity and decreased absenteeism benefits) were not measured directly and are discussed in the next section.

Table 8. Comparison of Estimated Telecommuting Benefits

Benefit	SCAG (SCAG, 1988)	County of San Diego (CSD, 1990)	State of California (JALA Associates, 1990)	City of Los Angeles (JALA International, 1993)
Travel Savings	$4.27 per occasion ($243.39 per year)	$0.64 per occasion ($36.21 per year)[10]	N/A	N/A
Misc. Savings	$2.15 per occasion ($122.55 per year)	$1.41 per occasion ($80.14 per year)[11]	N/A	N/A
Productivity Benefits	N/A	N/A	$3,815	N/A
Reduced Absenteeism	N/A	N/A	$200	N/A
Parking Space Savings	N/A	N/A	(negligible)	N/A
Office Space Savings	N/A	$1,440[12]	(negligible)	N/A

Notes: All results are per telecommuter per year, unless otherwise stated. N/A = not available.

3.2. Unquantified Results and Derived Assessments

Along with the cost-benefit results, we have other quantified results that are difficult to monetize without additional assumptions. In this section, factors such as employee productivity, employee retention, and perceived telecommuter benefit are discussed. Additionally, we explain why these factors are difficult to quantify and monetize.

3.2.1. Employee Productivity (or "Effectiveness")

Productivity, despite being one of the biggest assumed benefits, also remains one of the most difficult aspects to monetize. Labeled "employee effectiveness," JALA acknowledges that "the task of assessing effectiveness is fraught with possibilities for endless debate" (JALA Associates, 1990, p. 37). Nonetheless, JALA attempts to quantify and monetize these benefits.

[10] Total reported savings divided by 14 telecommuters and an estimated average 17 occasions each during the evaluation period, times an estimated 57 occasions per year in a permanent program.
[11] Includes food and dry cleaning cost savings.
[12] The County of San Diego estimated office space benefits, but this benefit was not measured directly and is based on an assumed telecommuting frequency of 40% (two days per week). No justification for the assumed reduction was provided.

The quantitative estimate of productivity is based on changes in performance during the telecommuting implementation period. A set of questions specifically pertaining to employee effectiveness and efficiency was directed to participating supervisors during both the midterm and final evaluations. These questions were then combined and quantified through factor analysis. After midterm and final factor scores were obtained, the difference between telecommuter's midterm and final evaluation responses was believed to quantify the change in effectiveness during the telecommuting pilot. This "measurement of increased productivity" was reduced by any increase in productivity experienced by the control group.

Once the change in effectiveness for telecommuters (over and above the change in effectiveness of the control group) was obtained, an average was obtained for all telecommuters. Then it was converted into a dollar value by multiplying the percent change in effectiveness by the "supervisors' estimates of the participant's salary" (JALA Associates, 1990, p. 38). For example, a 10% increase in overall effectiveness was monetized at 10% of the telecommuter's salary. The resulting "bottom line" benefit was calculated to be $3,815 per telecommuter per year. Not surprisingly, as noted in the City of Los Angeles report, "typically, supervisors' estimates of employee effectiveness are lower than those of the employees themselves" (JALA International, 1993, p. 23).

In other cases, telecommuters are asked to make quantitative, self-reported assessments of changes in productivity. For example, "I am 25% more productive when working at home than I am when working in the office." In this simplified situation, dollar values are obtained by multiplying this change in productivity by average telecommuting frequency per year and average annual salary. In the County of San Diego report, "both supervisors and participants overwhelmingly agreed that telecommuting improved productivity" (CSD, 1990, p. 10). While

"interviews with supervisors identified an estimated 40% increase in productivity," this increase was not monetized or valued in any other way (CSD, 1990, p. 10).

In general, it is difficult to quantify changes in productivity or effectiveness. Moreover, there remains some debate about what should be measured. The term "effectiveness" is preferred to the term "productivity" by JALA because "productivity" is related to a quantity of output while "effectiveness" is related to the quantity and quality of work. "Effectiveness" is further complicated because it difficult to quantify changes in perceived quality of work (for additional discussion of this issue, see Westfall, 1996).

3.2.2. Sick Leave

As with productivity, sick leave is often based on self-reported attendance. If attendance data is provided (maybe from a telecommuting log or a travel log), it is simply the difference in the number of sick days of the telecommuters less the sick days taken by the control group. The difference in sick days is taken as a percentage of time during the entire work year. This percentage is then multiplied by the average annual salary to obtain the average annual benefit. According to the City of Los Angeles report, the 1.1 fewer days of sick leave taken by telecommuters compared to the control group represented 0.5% of the average annual work time or about $200 per telecommuter (JALA Associates, 1990). While sick leave is easier to define than productivity, it too must be calculated from attendance data or worse – from self-reported attendance logs which are subject to biases by the respondent. As noted in the State of California report, "we suggest that if sick leave benefits are to be measured more exactly, actual time charges be used rather than … recollections" (JALA Associates, 1990, p. 38).

3.2.3. Recruitment/Retention

While it is often reported as a benefit, employee recruitment or retention is also very difficult to quantify. According to JALA, "aside from turnover numbers, it is clear that most agencies do not have a good idea of the costs of replacing employees." The State of California report concurs that "this is a problematic category," however it appears to have assigned a retention value based on the telecommuter's salary. In the pilot, 21 out of 107 survey respondents stated that telecommuting had been a "moderate to decisive influence on their decision to stay," although they "seriously considered leaving the State during the year" of the pilot.

> "Typical values from corporations for replacing mid-level people are in the range of $100,000 to $150,000. The highest agency estimate was $80,000 to $100,000, with most placing the cost at less than $20,000.… However in keeping with the agencies' estimates we placed the value of retained telecommuters in 1989 at half their salaries" (JALA Associates, 1990, p. 39).

Still, it remains unclear *how much* of a role telecommuting had in retaining an employee. Equally importantly, it remains unclear how much it costs to replace an employee when hiring and training costs are included. To complicate this issue, a distinction undoubtedly exists between the retention of a "highly-performing" employee and the retention of a "fair to average" employee. As with effectiveness, added value might be expected for improvements in *quality* as well as *quantity* of employees retained.

3.2.4. Perceived Telecommuter Benefits

An approach similar to the one used by JALA in 1990 to assess effectiveness was used by JALA in 1993 to assess telecommuter "work/social factor changes." A section in the evaluation questionnaires was prepared to assess "the socio-psychological effects of telecommuting" (JALA

International, 1993, p. 27). The only difference between the two approaches is that telecommuter changes were not monetized; they were only quantified following the factor analysis, as shown in Table 9. If there were a way to convert these work/social factors into a dollar value, then Table 9 could be useful. Left alone, however, these data have little use in a cost-benefit analysis, although they appear to demonstrate some important qualitative benefits of telecommuting.

Table 9. Work/Social Factor Changes

Factor	Telecommuters	Control	Difference (T–C)
Liberation	4.9	1.6	3.2
Continuity	3.1	1.3	1.7
Creativity	3.2	1.3	1.9
Personal Life	2.5	1.0	1.5
Environmental Influences	2.2	0.6	1.6
General Work Life	2.2	1.0	1.1
Stress Avoidance	1.2	0.3	0.9
Interdependence	1.0	0.5	0.5
Visibility	0.9	0.4	0.5
Belonging	0.6	0.3	0.3
Apprehension	0.7	0.6	0.1

Source: JALA International, 1993.

3.3. Other Micro-Scale Values

Aside from the four studies featured in this report, there are also a few studies that have reported empirical results but for which the details of their data collection are not available. In other words, we were not able to obtain actual reports from these studies, but instead learned about them from indirect sources. This section discusses these "secondary" studies that provide some additional cost-benefit data without the details regarding the methodology or the empirical setting:

- *Arizona Public Service Company Nuclear Fuel Management Telecommuting Pilot Program*
- *Puget Sound Telecommuting Case Studies (GTE Northwest and City of Redmond)*
- *Other Miscellaneous Sources*

Arizona Public Service Company Nuclear Fuel Management Telecommuting Pilot Program

After moving its facilities 80 miles and adopting a compressed work schedule (12-15 hour work days) in the fall of 1994, the Arizona Public Service (APS) Company's Nuclear Fuel Management (NFM) Department was facing excessive turnover of highly trained engineers.[13] As a result, "APS engineering management approved a six-month pilot program to evaluate the effects of telecommuting on employee performance" (Gil Gordon Associates, 1995, p. 1). According to the executive summary (Parrish, 1995), the specific goals of the pilot were to:

- Reduce costs associated with turnover and absenteeism;
- Increase organizational flexibility;
- Support employee trip reduction goals; and
- Increase staff productivity and effectiveness.

While the APS pilot only involved five telecommuters,[14] it still offers some useful contributions to the micro-scale cost data as shown in Table 10.[15] In particular, we see company-side network improvements (i.e. system network upgrades) that are not present in other

[13] A brief executive summary was written for the NFM project, but results were primarily made available to the public through two brief articles in telecommuting periodicals (*Teletrend* and *Telecommuting Review*).
[14] It originally consisted of six telecommuters, but one "dropped out after a week when he realized that he didn't like to telecommute" (Gil Gordon Associates, 1995, p. 1).
[15] Another product of this evaluation was the computer-based timelog evaluation system, similar to an activity diary. Employees coded their time during the day as being a personal activity, a production activity, an unplanned work-related activity (e.g. phone calls), an administrative activity (e.g. meeting), unproductive paid time off, and miscellaneous activities. The different activities were allocated different values. Based on the information in the timelogs, productivity gains were classified and quantified, then monetized.

studies. Additionally, we see telecommuter costs similar to those observed in the four micro-scale pilot project studies: computer prices between $1,500 and $3,000, and the installation of a dedicated phone line around $100. The NFM study also notes commuting cost benefits estimated at more than $2,500 per year (200 miles/week at $0.26/mile), and miscellaneous benefits of more than $620 per year ($40 per month for in-office expenses, such as food, and $12 per month for clothing expenses).

Moreover, the study concluded that a $6,000 per year benefit is "conservatively assumed due to reduced absenteeism and turnover costs" (Gil Gordon Associates, 1995, p. 3). These values were based on timelog data recorded by telecommuters. The study estimated that "total annual productivity gains range from 8% to 18% . . . bringing the total, gross annual value of the program [to the employer] to $15,000 to $28,000 per telecommuter" (*TeleTrends*, July 1996, p. 7).

Table 10. NFM Telecommuting Costs

One-Time Employer Costs	
LAN soft/hardware upgrade	$4,000
Pilot team program development costs	$3,000
Management review/approval costs	$4,000
One-time pilot team training costs	$2,000
Program management/evaluation costs	$6,000
Annual Employer Operating Costs	
Phone lines for two modems at NFM	$2,400
Computer services support (estimate)	$4,600
One-Time Telecommuter Setup Costs ($ per telecommuter)	
Home office setup	$3,000
Second phone line	$100
Annual Telecommuter Costs ($ per telecommuter per year)	
Second phone line	$240
Voice messaging service	$80

Source: Gil Gordon Associates, 1995.

Table 11. NFM Telecommuting Benefits

Annual Telecommuter Benefits ($ per telecommuter per year)	
Travel Cost Savings	$2,500
Miscellaneous Benefits	$620
Annual Employer Benefits ($ per telecommuter per year)	
Absenteeism and Turnover Benefits	$6,000
Productivity Gains (8-18%)	$9,000 to $22,000

Source: Gil Gordon Associates, 1995.

Puget Sound Telecommuting Case Studies

The Washington State Energy Office started its Puget Sound Telecommuting Demonstration Project in October 1990. The pilot project consisted of about 250 individuals (telecommuters, supervisors, and non-telecommuters) from 25 public and private organizations. Two of the participating organizations – GTE Northwest and the City of Redmond, WA – were

studied (along with a telework center), "to examine the benefits and impacts of telecommuting for specific organizations and the telecommuters" (Kunkle, 1992, p. iii). In particular, "emphasis was placed on the energy and cost impacts of telecommuting" (Kunkle, 1992, p. iii).

In these case studies, information from telecommuters was obtained through site visits and interviews. The case studies estimate the impacts from telecommuting "using information reported by telecommuters on commuting habits and office and home computer equipment, lighting, and heating systems usage.… Costs were estimated from information reported by telecommuters and the participating organizations" (Kunkle, 1992, p. iii). Cost data were not tracked by the organizations or telecommuters, thus, the reported costs "represent order of magnitude estimates" (Kunkle, 1992, p. iii). The fact that cost data were not originally tracked may be the reason for the large differences in the home-based start-up costs presented in Table 12 below. On-going costs for the two home-based telecommuting pilot projects are more similar and are presented in Table 13 below.

Table 12. Estimated Start-Up Costs from Puget Sound Telecommuting Case Studies

	GTE Northwest	City of Redmond
Training	$278 - $333	$60 – $80
Phone Lines	$22 - $28	$0
Modems	$31 - $36	$0
Software	$21 - $27	$0
Computers	$0	$0
Printers	$0	$0
Furniture	$0	$0
TC Workstation Setup	$361 - $416	$0
Administration	$500 - $556	$120 – $200
TOTAL	$1,210 - $1,400	$180 - $280

Source: Kunkle, 1992. Values are in dollars per telecommuter.

Table 13. Ongoing Costs from Puget Sound Telecommuting Case Studies

	GTE Northwest	City of Redmond
Administration	$40 – $67	$48 – $72
Computer Support	$100 – $167	$0
Telecommunications	$333 – $467	$7 - $10
TOTAL	$473 – $700	$55 - $82

Source: Kunkle, 1992. Values are in dollars per telecommuter per year.

According to the details available, the results are based on information provided by 18 telecommuters participating in the GTE study and 25 telecommuters in the City of Redmond study.[16] Similar to the SCAG and County of San Diego pilots discussed earlier, the two Puget Sound case studies represent a "low-cost approach to telecommuting" because the organizations tried to minimize support costs while encouraging its employees to telecommute (Kunkle, 1992, p. 24). Both organizations tried to use existing equipment for its telecommuters, rather than purchase new computers. GTE Northwest gave its telecommuters computer equipment from surplus, while the City of Redmond loaned out six existing laptops to telecommuters. In both cases, most of the setup costs were for training and administration, and these costs were estimated "based on estimates of typical professional employee costs (including benefits and overhead)" and were "not necessarily reflective of actual … costs" (Kunkle, 1992, p. 9).[17]

GTE Northwest estimated the total setup costs to be $1,210 to $1,400 per telecommuter, while the City of Redmond setup costs were estimated to be between $180 and $280 per telecommuter. Part of this discrepancy is simply due to the additional start-up support that GTE

[16] Although 23 telecommuters participated in the GTE pilot project, the case study presents results only from the 18 telecommuters who participated in the interview process.

[17] For GTE Northwest, typical staff costs of "$40/hr (including overtime and benefits) and $60/hr for supervisory staff" was assumed (Kunkle, 1992, p. 10). For the City of Redmond, typical staff costs of "$35/hr (including overtime and benefits) and $50/hr for supervisory staff" were assumed (Kunkle, 1992, p. 21).

Northwest provided for its employees which included the installation of a business phone line, the setup and support of a home workstation, and ancillary equipment purchases (such as modems and computer software).

In both cases, on-going costs consisted primarily of telephone costs. It was noted that "on-going support for the telecommuters and associated on-going costs were generally minimal" but that "telecommunications costs for business lines and long distance phone calls cost from $50 to $100 per month for some telecommuters" (Kunkle, 1992, p. iv). It was noted that for the GTE study about "half of the telecommunications costs were due to one telecommuter that required an almost continuous link to the mainframe computer at the office for software development" (Kunkle, 1992, p. 9). In both cases, telecommuters could be reimbursed for work-related long-distance phone calls and additional utility costs, but some employees did not bother to request reimbursement costs because they were so miniscule.

According to the case study summary, the "the primary benefits of telecommuting to the City of Redmond appear to be happier, more productive employees and support for transportation demand management" (Kunkle, 1992, p. 22). Productivity benefits were estimated by assuming an 8.8 % increase in productivity (based on the State of California study results) yielding benefits of $4,000 to $8,000 per telecommuter.

Additionally, the summary noted that the City of Redmond was remodeling during the telecommuting demonstration and experienced some space constraints. At the same time, it was noted that "telecommuting played a small role in easing this train" (Kunkle, 1992, p. 22). For the GTE Northwest case study, "the minimal office energy savings would amount to about $50 per year" and "if telecommuting reduced the need for leased space by 10 percent, the savings would be about $250 per year per telecommuter" (Kunkle, 1992, p. 11).

Telecommuter benefits were approximately $7 per month for GTE Northwest telecommuters and approximately $2.50 per month for City of Redmond telecommuters due to gasoline savings and reduced lunch or clothing costs, although "the actual amount varies substantially among telecommuters" (Kunkle, 1992, p. 11). The report indicates that "the key expense that reduced or eliminated any cost savings [for the telecommuter] were the long distance phone calls that the telecommuters paid themselves instead of submitting [to the employer]… for reimbursement" (Kunkle, 1992, p. 22).

Other Miscellaneous Sources

This section presents information on certain costs and benefits from a variety of sources. Most of the information is from secondhand references found in magazines or other sources. In each case, the second party source is cited and a brief explanation is provided:

1. Case study excerpts from "The New Buzz in Business" provided by the Southern California Telecommuting Partnership provide limited information on reducing overhead and real estate costs:
   - Movo Media, a telecommunications/entertainment company in southern California, claims to have reduced its overhead by $30,000 per year by allowing its 30 employees to telecommute (Southern California Telecommuting Partnership, 1996). This overhead reduction can be considered a direct benefit of telecommuting.
   - An IBM telecommuting program in Cranford, New Jersey started in 1994 is reported to result in a 75% reduction in the amount of real estate used and an annual cost savings of

$11 million (Southern California Telecommuting Partnership, 1996). The number of telecommuters participating in this program was not provided.

- IBM Canada is reported to have reduced its real estate needs by 10%, at an annual cost savings of $4 million (Southern California Telecommuting Partnership, 1996). According to this source, IBM estimated that as many as 20,000 employees telecommuted regularly, but it does not appear that the exact number of telecommuters (or their impacts) was documented.

2. In 1991, the Georgia Power Company in Atlanta started a telecommuting program involving 150 full-time telecommuters. Between 1993 and 1996, it was reported that a group of 15 telecommuters saved the company $100,000 annually by reducing their corporate office space requirements by two-thirds (Girard, 1998).

3. An article in *Computerworld* magazine indicated that Xerox Corp., the copier and imaging company, invests $10,000 to retain and attract information systems (IS) staff. "We basically make a onetime $10,000 deposit for each [IS] employee," according to Bob Monastero, director of human resources for the information systems department at the Rochester, New York (Wallace, 1998). If this cost to the employer can be mitigated by offering telecommuting work options, it is possible that a fraction of this initial investment can be considered a benefit to the company.

4. Another *Computerworld* article cites the AT&T Corp. as being able to save between $1,200 and $6,000 annually per employee in associated real estate costs, according to Susan Sears, a

telecommuting project director. The article does not indicate the number of employees over which this benefit was calculated (Cafasso, 1997).

Massachusetts Telecommuting Initiative (Boyd, *et al*., no date)

In 1994, the Massachusetts Division of Energy Resources (DOER) and the Federal Highway Administration through the Massachusetts Bureau of Transportation Planning and Development (Massachusetts Highway Department) sponsored a telecommuting pilot project to "study what specific impacts telecommuting has on companies, individuals and society" (p. 1).

While this study initially criticized studies of the 1980s for focusing on "broad societal benefits and consequences of reduction in vehicular commuting" (p. 1), its cost-benefit methodology was similar to those studies of the 1980s. Data from travel logs indicated that telecommuters saved, on average, 28 miles on each telecommute day. Combined with a reported telecommute frequency of 2.26 days each week, the report concluded that 400,000 miles per year would be saved due to telecommuting by the telecommuters alone if telecommuting continued for a year at those rates.[18] Assuming an average fuel economy of 21.48 miles per gallon[19] and an average cost of $1.29 per gallon, it was estimated that the 124 surveyed telecommuters saved 18,600 gallons of fuel, at an average cost savings of $194 per telecommuter per year.

3.4. Computer Packages

It is important to briefly discuss the growing number of proprietary software packages that are sold to assess an individual's or an organization's costs and benefits resulting from telecommuting. One example of this type of software package is entitled *TeleworkAudits* and is

[18] Calculation: 2.26 days/week x 28 miles/day x 52 weeks/year x 124 telecommuters = 408,029 person-miles/year.
[19] Based on 1994 U.S. Department of Transportation estimates.

produced by Telework Analytics International, Inc., a British-based company. For this package, detailed and specific pieces of information must be input by the user to ensure that few assumptions need to be made when calculating costs and benefits. The developers of these packages assume that users will be able to input direct cost/benefit data along with travel information and work requirements and habits (Appendix B contains an abridged version of each question posed to the *TeleworkAudits* user). While no assumptions are revealed to the user, it appears that the software developers minimize use of assumptions by requesting all information from the user. A potential problem with this type of package is that the user may not have all of the necessary information, and the package may not let the user proceed if certain information is not entered.

In general, while these packages may be helpful, they may not be practical because they require a great deal of input that the user may not have readily available. Moreover, it is not clear how all of these inputs are actually used to calculate costs and benefits and what inherent assumptions are made within the package.

3.5. Summary of Findings

A summary of micro-scale benefits is presented in Table , while a summary of costs is presented in Table . These values were obtained from a variety of sources and are presented for summary purposes. It is important to note the details and footnotes associated with each entry. In many cases, it is not clear what is being valued. For example, it is possible for telecommunications to involve anything from phone installation and service, to telecommunications software for a computer. For the most part, these tables are useful for identifying a range of values found in practice for each factor; however, the valuation of some of

the costs and benefits remains questionable. Moreover, not all of these values come from rigorous empirical studies. In fact, some values are estimates offered by promotional literature and may be biased in favor of telecommuting.

Table 14. Documented Benefits Per Telecommuter

Attribute	Value ($)		Organization (Source)
	One-Time	Annual	
1. USER (TELECOMMUTER) BENEFITS			
Travel Cost Savings	0	2,496[20]	(*Teletrends*, July 1996)
Travel Cost Savings	0	~243.39[21]	SCAG (1988)
Travel Cost Savings	0	36.21	County of San Diego (1990)
Travel Cost Savings	0	2,500	Arizona Public Service Co. (*Telecommuting Review*, Sept. 1995)
Other Cost Savings	0	~122.55[22]	SCAG (1988)
Other Cost Savings	0	620	Arizona Public Service Co. (*Telecommuting Review*, Sept. 1995)
Other Cost Savings ("in-office expenses")	0	480[23]	APS (*Teletrends*, July 1996)
Other Cost Savings ("clothing")	0	144[24]	APS (*Teletrends*, July 1996)
(Motor Vehicle) Insurance Savings	0	173	(Finlay, 1991)
2. EMPLOYER BENEFITS			
Productivity Increase	0	3,360[25]	(Coronado Telecentre, 1993)
Productivity Increase	0	3,815	State of California (JALA Associates, 1990)
Productivity Increase	0	9,000 to 22,000	APS (*Teletrends*, July 1996)
Productivity Increase	0	4,000[26]	(ITS-Davis Telecenters, 1993)
Reduced Overhead Expenses	0	1,000	(Southern California Telecommuting Partnership, 1996)
Reduced Absenteeism (sick leave)	0	243[27]	(Coronado Telecentre, 1993)
Reduced Absenteeism (sick leave)	0	200[28]	State of California (JALA Associates, 1990)
Reduced Absenteeism (sick leave)	0	1,000	(ITS-Davis Telecenters, 1993)
Reduced Absenteeism and Turnover	0	6,000	Arizona Public Service Co. (*Telecommuting Review*, Sept. 1995)

[20] Assumptions: 200 miles per week at $0.26 per mile.
[21] Estimated from SCAG value of $4.27 per telecommuting occasion.
[22] Estimated from SCAG value of $2.15 per telecommuting occasion.
[23] These "in office expenses" include lunches and snacks.
[24] These miscellaneous cost savings include wardrobe maintenance, dry cleaning.
[25] Assumption: Increased employee effectiveness averaging 12% of $28,000 average annual salary, telecommuting 1.5 days per week.
[26] Assumptions: Productivity is 20% of $20,000 average annual salary. $3,000 is due to increased "quantity," and $1,000 is due to increased "quality."
[27] Assumptions: Average 2 days per year reduction with $28,000 average annual salary in 230 workday-year.
[28] 1.1 days per year (0.5% of salary).

Parking Cost Savings	0	360[29]	(Coronado Telecentre, 1993)
Parking Cost Savings	0	0	State of California (JALA Associates, 1990)
Parking Cost Savings	0	200[30]	ITS-Davis Telecenters (1993)
Parking Cost Savings	0	216 to 810	(Finlay, 1991)
Office Space Savings	0	1,440[31]	County of San Diego (1990)
Office Space Savings	0	3,240[32]	Coronado Telecentre (1993)
Office Space Savings	0	0	State of California (JALA Associates, 1990)
Office Space Savings	0	1,800[33]	(ITS-Davis Telecenters, 1993)
Office Space Savings	507 to 1,140[34]	0	(Finlay, 1991)

[29] If applicable. An original estimate was obtained then (arbitrarily?) reduced by 30% to correspond to the "average reduction in parking space needed."

[30] An original estimate of $500 was obtained then reduced by 40%. No justification for the assumed reduction was offered.

[31] The County of San Diego estimated office space benefits, but this benefit was not measured directly and was based on an assumed telecommuting frequency of 40%. No justification for the assumed reduction was offered.

[32] Assumptions: 150 ft^2. Reduced from original estimate by 30% to correspond to "potential reduction in office space needed." No justification for the assumed reduction was offered.

[33] Assumptions: 150 ft^2 at a savings of $30 per ft^2 reduced by 40%. Original source: Schepp (1990). *The Telecommuter's Handbook*, 1990.

[34] In Canadian dollars.

Table 15. Documented Costs Per Telecommuter

Attribute	Value ($)		Organization (Source)
	One-Time	Annual	
1. USER (TELECOMMUTER) COSTS			
Additional Utility Costs (Gas)	0	114	State of California (JALA Associates, 1990)
Additional Utility Costs (Electricity)	0	17	State of California (JALA Associates, 1990)
Additional Miscellaneous Costs	0	18.29	County of San Diego (1990)
2. EMPLOYER COSTS			
Administration	500 to 556	40 to 67	GTE Northwest (Kunkle, 1992)
Administration	120 to 200	48 to 72	City of Redmond (Kunkle, 1992)
Training	300[35]	0	State of California (JALA Associates, 1990)
Training	68.86	0	County of San Diego (1990)
Training	500	0	(Finlay, 1991)
Training	150	0	Coronado Telecentre (1993)
Training	2,000	0	Arizona Public Service Co. (*Telecommuting Review*, Sept.1995)
Training	278 to 333	0	GTE Northwest (Kunkle, 1992)
Training	60 to 80	0	City of Redmond (Kunkle, 1992)
Recruiting/Training/Retention	0	1,000	(ITS-Davis Telecenters, 1993)
"Startup Costs"	500 to 1,000	0	(Finlay, 1991)
Software	1,500[36]	0	(Finlay, 1991)
Software	210	0	City of Los Angeles (JALA International, 1993)
Software	17.50[37]	0	County of San Diego (1990)
Software	21 to 27	0	GTE Northwest (Kunkle, 1992)
Software (communications)	150	0	(ITS-Davis Telecenters, 1993)
Software (word proc., spreadsheet, comms)	300	0	(ITS-Davis Telecenters, 1993)
Phone Installation and Service	100	240	Arizona Public Service Co. (*Telecommuting Review*, Sept. 1995)
Phone Installation and Service	0	15[37]	City of Los Angeles (JALA International, 1993)
Phone Installation and Service	4.72[37]	~9.67[37]	SCAG (1988)
Phone Installation and Service	12.93[37]	12.86[37]	County of San Diego (1990)
Phone Installation and Service	22 to 28	333 to 467	GTE Northwest (Kunkle, 1992)
Phone Usage	0	7 to 10	City of Redmond (Kunkle, 1992)
Phone Service	0	360 to 900[38]	(Finlay, 1991)
Phone Service	0	1,000	(*Teletrends*, July 1996)
Phone Service	0	360	State of California (JALA Associates, 1990)
Telecommunications ("services")	0	480	Coronado Telecentre (1993)

[35] Per "telecommuter-supervisor pair."
[36] Replacement every five years.
[37] See note on Table 7.
[38] $360 for an analog line, $900 for an ISDN line.

Telecommunications (phone lines, modems)	250	0	Coronado Telecentre (1993)
Telecommunications (voice mail)	7	60	(ITS-Davis Telecenters, 1993)
Telecommunications (voice mail)	0	80	Arizona Public Service Co. (*Telecommuting Review*, Sept. 1995)
Telecommunications (2-line telephone)	100	0	(ITS-Davis Telecenters, 1993)
Telecommunications (call waiting)	0	20	(ITS-Davis Telecenters, 1993)
Telecommunications (modem, software, hardware)	0	2,000 to 3,000[39]	(*Teletrends*, July 1996)
Equipment Support	0	100 to 167	GTE Northwest (Kunkle, 1992)
Equipment Support	0	76	City of Los Angeles (JALA International, 1993)
Equipment (printer)	270	0	(ITS-Davis Telecenters, 1993)
Equipment (fax machine)	480	0	(ITS-Davis Telecenters, 1993)
Equipment (personal copier)	530	0	(ITS-Davis Telecenters, 1993)
Equipment (modem)	31 to 36	0	GTE Northwest (Kunkle, 1992)
Equipment (modem)	200	0	(ITS-Davis Telecenters, 1993)
Equipment (computer)	1,500[40]	0	(ITS-Davis Telecenters, 1993)
Equipment (computer) Maintenance	0	250[41]	State of California (JALA Associates, 1990)
Equipment (computer) Support	0	4,600	Arizona Public Service Co. (*Telecommuting Review*, Sept. 1995)
Telecommunications Network Modifications	1,663 to 1,754[42]	0	The Rand Corp. (ADL, 1991)
LAN Software/Hardware Upgrade	4,000	0	Arizona Public Service Co. (*Telecommuting Review*, Sept. 1995)
Telecommunications Moving Costs (renovation/installation)	50	0	(Coronado Telecentre, 1993)
Facilities Leasing (furniture, insurance, equipment purchase/rental)	0	1,440	(Coronado Telecentre, 1993)
Facilities Leasing (furniture, insurance, equipment purchase/rental)	0	0[43]	State of California (JALA Associates, 1990)
Home Office Setup	3,000	0	Arizona Public Service Co. (*Telecommuting Review*, Sept. 1995)
Home Office Setup	361 to 416	0	GTE Northwest (Kunkle, 1992)
Insurance	0	0[44]	State of California (JALA Associates, 1990)
Work-Related Travel		~1.11[37]	SCAG (1988)

[39] $2,000 for home-office; $3,000 for company-office
[40] IBM-clone or Macintosh computer with 40MB hard drive [Source: Pacific Bell]
[41] Per employer-supplied computer.
[42] Per home. No source given.
[43] The State of California did not provide additional furniture to telecommuters.
[44] The State of California is self-insured.

4.0. CONCLUSION

A review and evaluation of micro-scale studies yields important information about the state of practice in economic evaluations of telecommuting. Studies often use similar methodologies, but with variation in the empirical results, even among studies conducted by the same agent. Not all costs and benefits are accounted for, and those that are accounted for remain specific to the "bottom line" of the employer, and fail to focus on the telecommuter. In general, many of these pilot studies were approved with the goal of evaluating the feasibility and cost-effectiveness of telecommuting from the employers' perspective.

While questionnaires and self-reported logs have been a popular and effective data collection instrument, a great deal of the collected data focuses on relative attitudinal and organizational issues, rather than on absolute factors that affect the overall costs and benefits. This attitudinal and organizational information is needed, however, if there is to be any way of measuring the "soft" costs and benefits that remain difficult even to quantify, let alone monetize.

In conclusion, it is important to realize that these studies only show part of the picture and should be used in concert with macro-scale studies. To fully understand the direct and indirect economic ramifications of telecommuting programs, care should be taken to include perspectives of the telecommuter, the employer, and the public sector, with the retrospective costs and benefits correctly assigned to each party. The idea, as noted in the SCAG study, is that "when pooled into a large sample, this information can give valuable insight into the transportation, energy, and telecommunications impacts of widespread telecommuting" (SCAG, 1988, p. III-2). Above all, we see that there is still a need for empirical telecommuting cost/benefit data collection focusing both on direct and indirect costs and benefits for the telecommuter and the employer.

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Appendix B. Inputs for the *TeleworkAudits* Proprietary Software Package

These questions were abridged from the *TeleworkAudits* package. Items in bold are *required* inputs, and the program will not allow the user to proceed until this information has been provided.

1. **Gross annual salary (including all benefits).**

Supervision

2. How many permanent full-time and part-time employees are on the payroll of your department?
3. Number of people with whom you have daily face-to-face contact.
4. Do you advise others? (If so, how many?)
5. Do you have a concern about subordinate's teleworking/telecommuting? (If so, why?)

Job Activities:

6. Are your tasks reasonably independent?
7. Do you travel on business? (If so, how often [days/month]?)
8. Besides commuting, do you make work related journeys? (If so, where, how, and how often?)

Work at Home:

9. Do you bring work at home at nights/weekends? (If so, how often?)
10. Have you worked at home during the day? (If so, how often? Why? Was your supervisor aware? Did you require formal approval? Does you company have a formal telework policy with its employees?)
11. During the past year, how many days have you been prevented from working due to: travel difficulties? Not feeling well? Family illness? Family Crisis?
12. During the last two years, have you left or changed jobs due to: birth of a child? Caring for a child? Caring for another's illness? Care for own illness? To relocate you home? Career advancement? Improve education?
13. In hindsight, could you have carried on working if telecommuting (from home or a local telecenter) had been available? (if so, full-time for home, full time from center, part-time from home, part-time from center, etc.)
14. **How many days per week do you usually work? (Standard is 249 days/year including holidays)**
15. How many days per year are you contracted to work?
16. **How many hours per day are you paid to work?**
17. What is the inter-departmental day charging rate for your time?
18. How many hours per day are you: on the phone? Meeting others face-to-face? Reading correspondence/memos/papers? Involved in group meetings doing research (not on a computer)?
19. Do you connect to a central computer via a LAN or WAN? (If so, how often per day? What do you do on-line?)

Teleworking:

20. Can you restructure your functions/responsibilities to allow you to work out of your home? (If so, how many days per week?)
21. Do you have the space and privacy to allow you to work from your home?
22. Can you rearrange your accommodations to provide you with the space you need to telework/telecommute?

23. From your home to your office, is the phone call local or long distance?
24. Do you attend regular client meetings? (If so, how often, average number of people at these meetings? Could you accommodate the meetings at home? Would your family agree to such meetings?)

Commuting:

25. How far do you live from your main work office, one way in miles?
26. How many minutes does your morning commute take, home to office?
27. How many minutes, office to home?

Method of commuting:

28. What is your means of commuting TO work each morning?

Commuting Costs

29. What are your average daily commuting costs? (including public transportation, carpool contribution, parking costs, and/or car running costs)?
30. How many gallons of gasoline do you use monthly for commuting only?
31. Does your employer provide you with a company car? Regional cost of living allowance? Car running costs? Allowance? Season ticket (train, bus, etc.)?
32. What make is your car?
33. What is its engine size?
34. Approximate price new?
35. Is this a company car?

Commuting:

36. Does your employer reimburse bus mileage? Commuting mileage?
37. During the last 12 months, approximately how many miles were you reimbursed for: business miles? Commuting miles?
38. Does your employer provide free parking?
39. Cost per day of parking near the building?
40. What is the approximate amount paid to you by your employer for travel tickets, hotels and associated expenses (but not mileage reimbursements): during the last year?
41. What is the standard travel expense per day?

Equipment

42. What company equipment or support would you continue to need if you teleworked/telecommuted from home 4 days per week? [pick from a list]
43. Do you have a desk or office for your exclusive use at your main office?
44. Do you have video conferencing available? (If so, on your office PC? On your home PC? How many times have you video conferenced in the last year?)

Job Specifics:

45. Does your job have any physical requirements or restrictions?
46. Are there security restrictions associated with accessing your organization's databases?
47. Do you have job performance objectives that are measurable?
48. If/when you work from home, do you wear business clothes or casual clothes?
49. Since leaving school or college, approximately how many training days have you had in total?
50. What is the average cost of a training day?
51. Do you have computer keyboard skills?

52. Do you find interruptions from or involvement in "office politics" and around the "coffee pot" to be: useful and informative, a nuisance but informative, a nuisance and a hindrance?
53. Generally, how many hours per day per person do you think are used in this way?
54. Since joining the organization, have you noticed: More computers on desks? More e-mail/electronic data interchange use? More people reporting or fewer people? "Process Re-Engineering" exercises?
55. More informal/tacit teleworking?
56. More formal teleworking?
57. Less/smaller work space areas?

Home:

58. When you work at the company office, is your home heated?
59. Estimated extra heating cost if working at home?
60. Did you claim tax relief on the use of your home as an office? (If so, how much during the last year?)

Food:

61. Does your company office supply free coffee, tea, or drinks? (If so, what would be the additional cost of supplying your own at home?)
62. Does your office have a subsidized cafeteria?
63. At office, what is your cost of food each day?
64. If working at home, how much would you spend on food each day in place of these meals?

Child/Elderly Care

65. Do you use child/elderly care while at the company office? (If so, what is your cost per week?)
66. If you worked from home, would you need such care during working hours?
67. How many people live in your home?
68. Pets?
69. Have you discussed setting up or operating a work center in your home with: your family? Your colleagues? Other teleworking/telecommuting families? Your immediate supervisor?
70. Have you been offered training/advice for teleworking?

Telework Area:

71. Where do you/could you have a work area if you teleworked?
72. How much space do you have for a work area (square feet)?
73. What kind of home environment do you have?

Teleworking

74. What do you like/dislike about teleworking?
75. Do you smoke during work hours? (If so, how often?)
76. On a scale from 1 to 10, how much would you like to telework?
77. Please select the description which most clearly matches your current job function. [select multiple choices]
78. Please identify furniture and equipment that you have in your office and what you have or need for telework. Insert cost/value of "need at home" ONLY. [many choices]
79. Please provide your best estimate of the changes you think would take place as a result of full-time (12 days per year at office) teleworking. [many choices]

80. Please indicate the anticipated effect of teleworking on the following work and lifestyle related issues [many choices, percent change].
81. Please indicate where your home is located relative to your main office (center of target) from a distance standpoint (in miles) by clicking on the location with the mouse (main office is at center.)