Travel Behavior Impact of Telecommuting Following the San Francisco Earthquake: A Case Study

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A severe earthquake in the San Francisco Bay area offered an unexpected opportunity to study the relation between telecommuting and travel behavior under emergency conditions. Coincidentally, the state agency with the highest participation in a state telecommuting pilot project was located in San Francisco. Interviews with pilot telecommuters, postearthquake telecommuters and managers in the Public Utilities Commission (PUC) revealed telecommuting as a flexible response to a transportation emergency that could be expanded without delay because it was a known and accepted work mode of that institution. The experience of the PUC suggests that increased telecommuting can help minimize work disruption within an organization that has previously implemented telecommuting. The number of days telecommuted was limited both by job-related factors and management policy. Although those persons already telecommuting before the emergency increased their number of telecommuting days only temporarily, if at all, new telecommuters were added, nearly half of whom were continuing to telecommute months after the emergency was over. Thus a short-term modification of behavior stimulated by emergency conditions led to long-term changes in travel behavior.

The Loma Prieta earthquake on Tuesday, October 17, 1989, provided a unique opportunity to study the travel behavior impact of telecommuting under emergency conditions. In San Francisco, Oakland, and other Bay area communities, buildings were severely damaged or destroyed, highways were structurally impaired, a freeway in Oakland collapsed, and one section of the Bay bridge collapsed. Closing of the San Fransicso Bay bridge for 1 month disrupted commuting, particularly for people living in the East Bay area and beyond. Commuting from the north and south also was slowed as many motorists from the east drove either north around the Bay, crossing into San Francisco by the Golden Gate bridge, or south, crossing the San Mateo bridge to reach peninsula highways (Figure 1).

In such a transportation crisis, a work breakdown or slowdown caused both by internal delays and interruption of delivery of goods and services from suppliers, consultants, and others on whom the primary institution depends might be expected. With a breakdown in transportation affecting commuters, increased absenteeism and tardiness would be expected. Even expanded ride sharing and mass transit use would not fully mitigate delays caused by the streets and transit system's being used to overcapacity.

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Such a transportation emergency would seem an ideal situation for an organization to implement widespread telecommuting, that is, to take commuters off the streets by allowing staff to conduct their work from offices in their homes. At the time of the earthquake, one large public institution, the California State Public Utilities Commission (PUC) had had trained telecommuters in place for about 1½ years as part of a 3-year pilot telecommuting project for state employees (1). The focus of this study was to probe the changes in telecommuting that took place, and why the amount of telecommuting increased, decreased, or remained the same.

Did the telecommuting patterns of the pilot telecommuters change in response to the emergency? If they were already successfully telecommuting 1 or 2 days a week, they might increase their work at home to 4 or 5 days. Did additional staff begin to telecommute and, if so, did they stop telecommuting when the Bay bridge reopened? If management favored telecommuting, the number of telecommuters would increase in response to the emergency. But would the new telecommuters be permitted to continue telecommuting once the emergency was past?

Finally, were the factors that either favored or limited telecommuting objective, that is, task-related, equipment-related, or a function of ride sharing arrangements, or were subjective factors overriding, such as employer and employee attitudes regarding the benefits or disadvantages of telecommuting?

BACKGROUND

The California Telecommuting Pilot Project, planned in 1985, was implemented beginning in mid-1987 (2). The author participated as a consultant. Most of the pilot telecommuters were not affected by the earthquake because they lived and worked in the Sacramento area. Of 14 participating agencies, only the PUC is located in San Francisco. Although the majority of PUC telecommuters live in the Bay area, some commute from homes located over 50 mi from their jobs (3). Evaluation of pilot telecommuters compared with a matched group of controls has been documented (4). Results of a separate, largely anecdotal, study of a sample of both PUC pilot telecommuters and PUC staff who began telecommuting in response to the emergency are described in the following sections.

FIGURE 1 San Francisco Bay Area commuting routes.

SURVEY METHODOLOGY

Sample

A telephone survey was conducted within the PUC, which "has the largest number of participants in the State's Telecommuting Pilot of all the state agencies" (*4*). As of June 1989, the reported number of total state telecommuters was 230, with 71 working in PUC (*5*). Assuming similar participation 4 months later, at the time of the emergency, about 8 percent of the PUC Bay area staff of 880 had been telecommuting for nearly 1½ years.

Forty-five professional staff from 5 of the largest of the 10 divisions within the PUC were surveyed (Table 1) (*3*). None of those interviewed held clerical positions. The sample included 20 pilot telecommuters out of a total of 30 who began telecommuting about May 1988, one of four midpilot tele-

commuters who began 4 to 6 months later, and three managers who themselves telecommuted. All were scheduled for training May 19 and 20, 1988. Additionally, five chiefs or managers who did not telecommute were interviewed.

The remaining third of the sample consisted of postearthquake telecommuters who began telecommuting after the earthquake occurred. Sixteen of 33 people mentioned by coworkers or managers as having begun to telecommute after the earthquake were interviewed. One of those was a manager. Another prepared to telecommute but never actually started.

A supplementary sample of 8 pilot, 1 midpilot, and 17 postearthquake telecommuters was composed of persons on the training lists and new telecommuters who could not be reached for interviews. Information about their telecommuting was obtained from managers and coworkers who were in the survey sample.

TABLE 1   SAMPLE OF TELECOMMUTERS AND MANAGERS INTERVIEWED

| Group | Pilot Telecommuters | | Post-Earthquake Telecommuters | | Non-Telecommuting Managers |
	Total	Interview Sample	Total	Interview Sample	Interview Sample
Initial Telecommuters	30	20	32	15	
Mid-pilot Telecommuters	4	1			
Telecommuting Managers	6	3	1	1	
Non-telecommuting Managers					5
TOTALS	40	24	33	16	5

Interviews

Semistructured telephone interviews were used to elicit the rich detail of personal attitudes and perceptions about telecommuting that might not be revealed in responses to written questionnaires. In order to obtain as full a view as possible of the telecommuting experience from the interviewee's perception, questions were not held strictly to a specific wording or sequence. The interviews were begun December 18, 1989, 2 months after the earthquake (1 month after the Bay bridge reopened) and completed April 20, 1990, 6 months following the emergency. Some persons on the training lists did not actually attend the training; others could not be reached after several telephone calls. Information about some telecommuters who had been transferred or who could not be reached by phone was obtained from their managers and coworkers.

Telecommuters were questioned about their telecommuting pattern before, immediately after, and 2 to 6 months following the earthquake, their job title and branch, and where they lived. They were asked to describe their home office work place, how it was equipped and whether they had adapted it for telecommuting. Finally, they were asked whether they felt they were more productive when they worked at home and, if so, in what way.

Managers of telecommuters were asked the size of their groups, the names of their telecommuters, and if they telecommuted themselves. They were then asked to recall the memoranda or briefings they received on handling the emergency, the means they used to offer these options to their groups, and the names of those who chose telecommuting. They were questioned about their selection critieria for post-earthquake telecommuters, and any observed differences between them and pilot telecommuters. They were asked if they planned to continue telecommuting within their group indefinitely.

Managers and coworkers also were asked about other people in their groups who were telecommuting before, immediately after, and months following the earthquake. The persons named are referred to as the "supplementary sample" of 26 telecommuters.

FINDINGS

Travel Behavior before the Earthquake

Before the earthquake, the California Telecommute Pilot Project conducted an impact assessment of telecommuting on trip rates. On the basis of a sample of 66 telecommuters (representative of all pilot telecommuters including the PUC subgroup), the study found that "telecommuting indeed reduces peak-period trips while adverse impact (e.g., increase in nonwork trips) is not apparent." The decrease in daily average trip rates "shown by the telecommuter employees is almost twice that of the control group employees . . ." which confirms that "telecommuting leads to an overall reduction in trip generation" (6).

Although up to 3 days per week telecommuting was said to be permitted as PUC policy, there was no evidence that before the quake anyone was telecommuting more than 1 or 2 days per week. Of the interviewed sample, four never started and four stopped for equipment, job-related, or personal reasons (see Table 2). According to their coworkers, some of the pilot group who were not interviewed telecommuted only a few days, or never started, for reasons such as retirement, transfer to another branch, owning an incompatible computer, and limitation of telecommuting to the period of a maternity leave. Telecommuting days that were missed for any reason could not be rescheduled. These anecdotal findings are consistent with midterm and final reports that state participants telecommute, on the average, 1.5 to 1.6 full days at home (4,5).

Management Response to the Earthquake Emergency

In the chaos resulting from the quake, the San Francisco PUC headquarters building was closed and the computers were down. Wednesday through Friday, employees were put on administrative leave, although reportedly several telecommuters continued to work (4). By the following Monday, October 23, when employees were expected back to work, one division manager already had telephoned managers and decided to increase the numbers of telecommuters. At a meeting held that afternoon, the top managers in the division discussed the emergency and, as one option, they formalized the rules to expand telecommuting. Managers in other branches recalled a similar story. That first day they were back, the executive director authorized adding telecommuters with complete branch discretion in helping staff get to work in that difficult period. Other options included a compressed work week, decreasing the required core hours, allowing staff to start earlier to shift travel to off-peak hours, added parking incentives for carpools, and larger discounts on transit passes (3). (A 9/80 compressed work week schedule, for example,

TABLE 2   POSTEMERGENCY TELECOMMUTING BEHAVIOR OF
PILOT GROUP

Reason	No. of times mentioned
8 Pilot Telecommuters Not Telecommuting at Time of Emergency	
4 Never started, and did not start telecommuting after emergency	
No computer or incompatible computer at home	2
Changed to compressed work week	1
Personal preference	1
	4
4 Stopped before earthquake and did not restart telecommuting after emergency	
No computer or incompatible computer at home	1
Face-to-face meetings required	2
Field trips	1
Traffic returned to normal	1
Transferred to another group	1
Personal preference	1
	7
16 Pilot Telecommuters Telecommuting at Time of Emergency	
1 Increased telecommuting	
Completed seasonal task	1
3 Decreased telecommuting after temporary increase	
Travel	1
Personal preference	1
Field work	1
	3
8 Did not change telecommuting during emergency	
Commuted on BART	4
Moved to San Francisco	1
Supervisor restriction	1
Traffic returned to normal	1
No reasons given	1
	8
4 Decreased or stopped telecommuting	
Business travel	1
Field work	1
Supervisor attitude	2
Worked in district office	1
	5

means working 9-hr days for 8 week days, 8 hr for a 9th day, and not working on the 10th weekday.) Later that same day or the next morning, managers called together their entire staffs and discussed options and passed the word along in memoranda. One postearthquake telecommuter recalled a note from the Information Resources Department explaining that telecommuting was an option and asking "if you have a computer and can you call in or log in." Telecommuting was completely voluntary for the employee but required the supervisor's approval.

Travel Behavior Immediately after the Earthquake Emergency

Change in telecommuting patterns related to the emergency were primarily a function of the telecommuter's job requirements at the time. Reasons for decreasing the number of telecommuting days or stopping altogether were similar for both pilot and new telecommuters.

Pilot Telecommuters

Of the 21 pilot telecommuters and 3 telecommuting managers, only 1 permanently increased his amount of telecommuting (from none before the earthquake to a sustained 1 day per week) immediately after the earthquake (Table 2). Coincidentally to the earthquake, he was able to work Wednesdays at home beginning in October because he finished a seasonal period that had required his supervising in the main office. Three people temporarily increased their telecommuting. One of those people who was doing earthquake-related field work telecommuted part time 5 days a week, reporting from home by the office automation system. Eight telecommuters did not change their schedules. One of the eight, for example, who lived in San Francisco, became a priority person to staff the office. Four people decreased or stopped working at home on their scheduled days. Finally, none of the four who had never started telecommuting nor the four who had stopped before the earthquake started to telecommute because of the emergency.

Those who did telecommute benefited from not having to drive or take mass transit when the Bay bridge was down. Bay Area Rapid Transit (BART) parking lots were full and parking was difficult to find nearby; trains were crowded and late. On days when they worked at PUC, employees coped by commuting outside peak periods, parking at friends' houses when they rode BART, and commuting by the ferry that was put into emergency operation.

Postearthquake Telecommuters

The postearthquake telecommuters added as a result of the policy change circulated from the executive director of the PUC were concentrated in C division, which had taken immediate aggressive action to expand telecommuting. That division added 32 new people (Table 3). Within the division, managers who already had telecommuters tended to let additional staff telecommute. One manager of 18 people, for example, had three pilot telecommuters, and added eight. Another manager's group of 21 had two pilot telecommuters and added four. That group had 3 or 4 people on compressed work week and another 14 whose commuting did not change after the earthquake.

The four other sampled divisions were less active in expanding telecommuting. Only one new telecommuter was added—in Division B—although all four had pilot telecommuters. Many of one manager's group lived in San Francisco or on the Peninsula, so nothing changed, no additional telecommuters were added. In other groups, the reason was upper management's not permitting both compressed work week and telecommuting. In some groups, a lot of employees preferred a compressed work week. Some worked flextime, i.e., they worked 8-hr days but not from 8:00 a.m. to 5:00 p.m. One employee, for example, worked from 6 a.m. to 2:30 p.m. to cut commuting time from 1½ hr to 25 min.

But there may have been employees who did not think of themselves as telecommuters. For example, the counts may underreport telecommuting in Divisions D and E whose employees were out in the field full time doing safety inspections of structures following the earthquake. As a pilot telecommuter in one of the divisions remarked: "I guess you could say they were telecommuting since they were doing field work reports at home and sending them in via their computers just like I was, but they weren't officially on the program."

Long-Range Changes in Telecommuting

Pilot Telecommuters

In an effort to estimate the pattern of telecommuting following the emergency, that is, to understand whether telecommuting was continued under normal conditions, individuals, managers, and peers were asked for names of people who were and were not telecommuting at that time. The numbers convey a sense of the telecommuting pattern, but should not be taken as an absolute count. Sixteen of 34 persons (47 percent) listed on the May 19–20, 1988, training schedules as pilot telecommuters (but not managers) were telecommuting at least 2 months after the earthquake. They continued their preearthquake telecommuting pattern, typically using BART to get to work the other 3 to 4 days. Eight of the group (26 percent) never started. The one person mentioned earlier who started telecommuting after the earthquake coincidentally, because his work finally permitted him to begin, continued to telecommute. Three people had stopped telecommuting before the earthquake. Incomplete information was obtained for the remaining six. Two or more months after the emergency, one of four midpilot telecommuters was still telecommuting; another had stopped. Whether or not the others were still telecommuting could not be determined.

Of the interviewed pilot group who continued to telecommute, eight had computers, three did not. Three pilot telecommuters who owned computers stopped for reasons such as travel or field work, rotation to another groups, and for personal reasons. Other reasons for not continuing to telecommute included lacking a computer at home, change in task demands, supervisor attitude, and a personal situation or preference such as changing to a compressed work week, wanting to ride in a carpool with a spouse, or wanting to take advantage of the PUC child care facility.

Postearthquake Telecommuters

Thirty-two employees were named by managers or coworkers as having begun telecommuting in response to the emergency. Sixteen (50 percent) started and were continuing to telecommute at the same rate for at least 2 months after the earthquake with the exception of two persons who telecommuted fewer days because of the holidays, business travel, and easier

TABLE 3   DISTRIBUTION OF TELECOMMUTERS WITHIN PUC DIVISIONS

Division	Pilot Telecommuters	Post-Earthquake Telecommuters
A	2	0
B	12	1
C	18	32
D	5	0
E	3	0
	40	33

commuting. Twelve (38 percent) telecommuted for 1 month, then stopped. Another four individuals were identified as telecommuting after the earthquake but coworkers were not sure whether they had continued after the Bay bridge reopened.

As discussed later, having a computer in the home office influenced whether or not the postearthquake telecommuters continued to telecommute after the emergency was over (Table 4). Because they used a computer in the main office, they were limited in the tasks they could carry out at home. Other factors affecting telecommuting behavior included not liking to carry bulky work materials back and forth, particularly if they commuted via mass transit, transfer to another group, because they had completed the report or task, and interruption of telecommuting by the holidays.

Those who reported business travel and face-to-face meetings required were staff who needed to be at PUC the days they were in the city to interact with other members of their groups.

This study did not uncover any telecommuters who had stopped because a manager was dissatisfied with their performances. With regard to postearthquake telecommuters, it may have been too soon to identify problems at the time managers were interviewed. (If there were any pilot telecommuters in that category, they likely were no longer in the program.) However, telecommuters were alert to their supervisors' general attitudes toward telecommuting and adjusted their requests to telecommute accordingly.

The new telecommuters felt positive about their experience. Most people worked alone in their homes in either a separate room or place such as an alcove of the living room or hall desk. Despite the fact that many postearthquake telecommuters lived in the east Bay region with available mass transit, they began and continued to telecommute.

Managers' Attitudes and Perceptions

Managers generally were satisfied with telecommuting, and planned to continue it within their groups indefinitely. As one supervisor commented, "it wasn't division policy to cut back. We play it by ear. We're more relaxed—so long as there is no problem." Another understood that "after a while in some groups they had telecommuters who couldn't concentrate at home. Telecommuters had small kids or other distractions." The supervisor makes it clear to his group that telecommuters can stop and restart again when the home situation permits.

After the earthquake, managers did not use the selection process required for the pilot group. "Since it was an emergency, anyone who wanted to telecommute, we tended to say 'yes.' " One manager felt that the pilot only was needed "so if the state decides to form a policy we'll get our say as to our needs. They didn't have to have the pilot in order to telecommute. A manager could say OK, work at home. We have lots of authority delegated to us. A lot of staff wanted to telecommute once in awhile. Upper management told supervisors that they had flexibility and should be lenient. After the earthquake they allowed some people to telecommute who wouldn't have [been allowed to] otherwise."

Managers noticed little difference between the pre- and postearthquake telecommuters. "We kind of monitor them.

TABLE 4   EMERGENCY-RELATED TELECOMMUTING BEHAVIOR OF POSTEARTHQUAKE GROUP

Reason	No. of times mentioned
32 Post Earthquake Telecommuters	
14 *Continued telecommuting*	
2 *Decreased telecommuting*	
Business travel	1
Holidays	1
Commuting easier	1
	3
12 *Telecommuted one month, then stopped*	
No computer, no office automation access from home	4
Task-related, e.g. project finished	2
Bulky reference materials inconvenient to carry back and forth	1
Business travel	1
Face-to-face meetings required	1
Holidays	1
Reason not reported	5
	15
4 *Long range telecommuting unknown*	4

Some people gave more than 1 reason.

The new telecommuters are the type we would have chosen anyway. The earthquake took waverers and added them to the program." Typically, like the pilot telecommuters, post-earthquake telecommuters submitted a work plan to their supervisors for approval. It was then passed to the manager. Supervisors had a positive perception of work effectiveness: "Seeing the work done it was obvious that telecommuters were doing at least 8 hours work at home." "If anything the productivity has increased" and telecommuting was "good for morale."

Managers who were less enthusiastic about telecommuting remarked that "too many changes are being made." One manager would accept one more telecommuter, but feels he doesn't have highly motivated, responsible people, and more-over, has not had strong requests by staff to telecommute. Another manager is afraid that "if telecommuting becomes a right, employees I don't trust would get to work at home. Telecommuting depends on the individual." He wants tele-commuting to be a managerial option. He knows the capa-bilities of his staff—"we have people we'd rather not have."

Most of the managers interviewed feel that so long as there is reasonable structure they will support telecommuting. The questions are "Will the telecommuter be available?" "Is the telecommuter there when you call at home?" "Does he have a PC, modem, and office automation connection?"

DISCUSSION OF RESULTS

Factors Promoting Telecommuting

The PUC initiated a 5-year Transportation Management Pro-gram in 1989. That transportation and energy conservation policy was reaffirmed after the quake: "Our current objective is to continue the post-quake reliance on public transit, ride-sharing, flextime and telecommuting in the Bay Area" and maintain the 50 percent reduction in single-occupancy vehicle travel by its employees that was achieved from 1989 to 1990 (*3*). That commitment appears paramount in analyzing why people who began telecommuting to mitigate the impact of an emergency continued to telecommute when normal con-ditions were restored.

What part did the State Pilot Telecommuting Program play in opening opportunities for more employees to telecom-mute? Having a trained body of telecommuters in place with managers enthusiastic about or, at worst, tolerant of telecom-muting for their own people, was critical. Also influential was verbal endorsement by the governor of California on Tuesday, October 24, 1989, a week after the earthquake. On October 31, the governor issued Executive Order D-82-89 requesting all state agencies, among other measures, to "implement tele-commuting procedures and programs to increase work at home or at satellite facilities." In late November, the Department of General Services held management briefings on "Telecom-muting During the Earthquake Recovery: Mitigating Traffic Congestion and Office Space Options" to PUC and other state agencies. However, evidence gathered from employee and manager interviews suggests that new PUC telecommuters were added prior to the briefings.

Discrepancies in the reported numbers of telecommuters blur the extent of telecommuting. Even in a formal telecom-muting program, work assignments interrupt telecommuting schedules, sometimes for indefinite periods of time, so that accurate counting of telecommuters is difficult. This study found that neither managers nor coworkers were always up-to-date on who was telecommuting.

Most employees enthusiastically endorse telecommuting and feel they are more productive working at home. Under emer-gency conditions, telecommuters saved time and stress by not having to leave their homes early in the morning and commute on overcrowded streets and mass transit. One employee could sleep an extra 2 hrs, so felt the quality of her work was better. But also under normal conditions telecommuters report work-ing "harder at home than at PUC because there are no in-terruptions." "At PUC they work in cubicles and you can hear everything . . . so I get most of my work done at home." Telecommuting saves transportation time and "you don't have to stop for lunch so you have long stretches of time to work in." Moreover, telecommuters were pleased about their pro-ductivity: "I don't even think about the time I'm not being paid. I just get the job done. It's more relaxing at home, more productive. When I come in to work I have to get up, get ready, get to the bridge, get here, get set up, while at home all I have to do is start."

Factors Limiting Telecommuting

Policy

In spite of PUC's stated goals to encourage telecommuting, several guidelines acted to limit the number of telecommuters and telecommuting days. First, there was a perceived pol-icy that forced the worker to choose between telecommuting and a compressed work week. Some managers thought the policy was in effect; another thought it had been changed in response to the emergency and might or might not have been reinstated.

Limiting telecommuting to 2 or 3 days did not appear to affect the actual time telecommuted because of workers' task-related needs to be at the main work site, to travel, or perform work in the field. The more serious barrier to increased tele-commuting is the limitation of each telecommuter to an ap-proved schedule of, for example, Tuesday and Thursday or Monday and Wednesday home-based work. A telecommuting day cannot be rescheduled if telecommuters are called for a meeting or needed elsewhere on their home office days. Some postearthquake people who stopped telecommuting might have established a routine if the end of the year holidays had not disrupted their schedules so soon after they had started to telecommute. Because they could not make up days that fell on a holiday, many found their actual number of days at home to be very few.

PUC's policy of training some of the staff by rotating them among branches for periods of 6 months deters telecommuting in two ways: first, telecommuters are uprooted from estab-lished telecommuting patterns by placement in new groups in which they are neither well enough known by their supervisor nor familiar enough with their new tasks to work at home immediately. Some transferred individuals hoped to be per-mitted to start telecommuting again when they had worked a little longer with their new branch. Second, having flexible work options as well as staff rotation gave some managers the perception that everything was changing at once, leading to chaos.

Their supervisor's attitude was mentioned by several people as the reason they stopped telecommuting. Although managers who were less than enthusiastic about PUC's policy apparently did not deny their staff the opportunity to telecommute, they did nothing to encourage it. From the perspective of a telecommuter, "the general lack of organization in the office forces the organization to rely heavily on the presence of people. Management reacts to crisis management." Telecommuting gives him "three hours of life," and he "wouldn't mind working in those three hours rather than fight traffic." Another telecommuter felt his supervisor's attitude is changing because telecommuters "are showing they do good work."

Equipment

Although lack of a computer did not deter most people from starting to telecommute after the earthquake, it did affect whether or not they continued after the first few weeks. Lack of a computer at home was the most common reason given by the postearthquake group for stopping telecommuting. Four of the 12 who stopped said they needed a computer at home (8 are known to have had them). Several mentioned the importance of sending files back and forth on the office automation system. Other factors also affected telecommuting behavior.

Three pilot telecommuters also stopped telecommuting for lack of a computer and one never started because his computer was incompatible with the office automation system. Of the interviewed pilot group who had not stopped telecommuting, 13 had computers, 3 did not.

Many telecommuters from both groups added equipment at their own expense. They had purchased a phone outlet, business line, a 386SX computer (because a borrowed portable "fails so much it's frustrating to use"), modem, software, and office furniture. One completely equipped a home office feeling that "it was an obligation to set up a home office with communication with everyone before starting to telecommute." Several people mentioned that the state pays for a call-back system on the office automation system so the employee does not have on-line telephone charges.

Being on the office automation system was crucial to getting the job done from a home office. Of 19 computers owned by telecommuters (both groups combined), only 2 were not equipped with modems. According to the Information Resources Department, before the earthquake, 180 telecommuters in state agencies had been given a security password to reach a port selector on the office automation system. Following the earthquake, 30 more telecommuters were added. Because of incompatible equipment, several telecommuters had only partial use of the office automation system; they could send notes but not edit files.

CONCLUSION

The Loma Prieta earthquake created an emergency travel problem that could be mitigated by telecommuting. The existing pilot set a precedent such that adding telecommuters did not require an organizational change. Because the PUC organization was prepared with a tested plan in operation, managers were able quickly and smoothly to add telecommuting volunteers. The disaster created a sudden increase in incentive for management to expand the concept. Managers and staff knew what telecommuting is and how it worked at PUC. New telecommuters could and did ask their pilot telecommuting coworkers about the experience before deciding to volunteer. Telecommuting reduced stress because employees did not have to change their travel times or be subjected to long commutes on overcrowded freeways and public transit. Work disruption within the organization was minimized. Particularly important was the ability of workers in the field conducting critical safety checks to send back reports by computer from their homes. The division that had the most telecommuters before the earthquake added the most in response to the emergency. Managers seemed comfortable with telecommuting in their departments and expected it to continue. Those not enthusiastic about telecommuting admitted it had benefits but, in actuality, their own groups had people on a compressed work week with few or no telecommuters.

Evaluated in terms of the pilot project guidelines, pilot telecommuters increased their telecommuting time only temporarily, if at all, then returned to preearthquake schedules when the Bay bridge reopened. But looking at telecommuting in a broader sense, the pilot group who were on business travel, out doing field work, or working in a district office also were telecommuting. New telecommuters were added who continued to telecommute. Nearly half were still telecommuting when interviewed 2 to 6 months after the earthquake. Most of those who had stopped telecommuting did so, not because of dissatisfaction with telecommuting, but for equipment, job-related, or personal circumstances. Travel behavior changed because telecommuting as a work option was given permission under emergency conditions that was not rescinded when traffic returned to normal.

In contrast to the California PUC, a Texas newspaper publisher had no preexisting telecommuting program when disaster struck. Under more transitory emergency conditions—a fire that shut down the press room—the Dallas Times Herald improvised work from homes and satellite locations in hotel rooms. Management did not think of the experience as telecommuting. Unlike the PUC experience, the incident did not result in permanent change in travel behavior. No policy changes resulted, only the lesson learned that every paper "has to have a doomsday defense set up . . . a fall back" (7). This one comparison suggests that long-term travel reduction will not be achieved unless management is educated about the concept and benefits of telecommuting under normal business conditions.

The telecommuting behavior of pilot and postearthquake telecommuters revealed in this study suggest the following employer actions that would promote long-term telecommuting:

● Provide computers for use in home offices or laptop computers equivalent in performance to telecommuters' on-site equipment,
● Supplement employee-owned equipment as needed with a modem and updated hardware and software,
● Pay telephone costs or costs for a call-back system on the office automation system,
● Make available duplicate copies of bulky reference materials or provide scanning assistance from the central office,
● Publicize top management support of telecommuting to encourage reluctant middle managers to participate,

- Publicize policy that staff may both telecommute and work compressed work weeks, if that policy is in effect,
- Permit shifting and make-up of telecommuting days where feasible, and
- Explore ways to accommodate telecommuting within the staff rotation program.

As for future plans at the PUC, the internal Employee Transportation Plan proposes continuing telecommuting as one option to promote alternatives to single-occupant vehicles. Specifically to expand telecommuting participation, the plan recommends (a) purchasing 10 to 15 laptop computers, (b) doubling the telephone lines to 18 (to accommodate 10 to 15 more telecommuters), and (c) over the next 5 years installing an additional 18-port dial-in unit to the office automation system (3).

The present findings suggest that several times more than 15 additional telecommuters could be anticipated so far as task-related factors are concerned. The study identified 33 new telecommuters by name, examining only half of the divisions, albeit the largest, in PUC. Added because of an emergency, most new telecommuters, if their tasks permitted, would continue to telecommute. Providing laptop computers would help those who travel or work in the field or do not own a computer although employees express their willingness to equip their offices at their own expense. Of even greater priority is access to the office automation system that many telecommuters increasingly need to perform effectively from home. Finally, it is apparent that more research is needed on the factors determining choice of telecommuting versus a compressed work week to anticipate travel behavior when planning transportation management programs.

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