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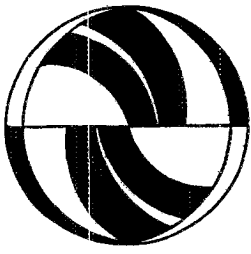
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Authors

Mokhtarian, Patricia L.
Salomon, Ilan

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**Modeling the Choice of Telecommuting:
Setting the Context**

Patricia L. Mokhtarian
Ilan Salomon

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Modeling the choice of telecommuting: setting the context

P L Mokhtarian

Department of Civil and Environmental Engineering and Institute of Transportation Studies,
University of California, Davis 95616, USA

I Salomon

Department of Geography, Hebrew University, Jerusalem 91905, Israel

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Abstract In this paper a conceptual model of the individual decision to telecommute is presented. Key elements of that decision, including constraints, facilitators, and drives, are defined and the relationships among them described. The major types of constraints (if negative) or facilitators (if positive) include external factors related to awareness, the organization, and the job, and internal psychosocial factors. The major types of drives are work, family, leisure, ideology and travel. It is argued that the absence of constraints is a necessary but not sufficient condition for telecommuting to be adopted by an individual. The presence of one or more drives, assumed to be associated with some dissatisfaction, is necessary to activate the search for a solution to that dissatisfaction.

The choice set contains those alternative solutions perceived to be feasible by the individual. It may or may not contain telecommuting (depending on whether all constraints are nonbinding or not), and probably contains other alternatives having nothing to do with telecommuting. Each alternative is evaluated in terms of how effectively it satisfies the drive, and the individual's attitudes toward it. The alternative (or bundle of alternatives) which maximizes individual utility becomes the preferred behavioral pattern. However, short-term constraints may prevent the preferred behavior from being chosen. The process is a dynamic one, in which previous choices affect attitudes and constraints and alter drives. Work directed by the authors is under way to operationalize the conceptual model.

1 Introduction

Telecommuting, as it is commonly practiced in the United States, may be defined as using telecommunications technology to work at home, or at a location close to home, during regular work hours, instead of commuting to a conventional work place at the conventional time. It may be part-time or full-time, and need not exclusively involve computers (Mokhtarian, 1991a, 1991b).

Telecommuting is gaining acceptance in the USA and elsewhere, for a variety of business and public policy reasons. In particular, it is being widely discussed and implemented as a mitigation strategy against congestion and air pollution. The potential impact of telecommuting on travel is complex, and not necessarily completely beneficial (Salomon, 1985). The consensus of current empirical research (Hamer et al, 1991; 1992; Kitamura et al, 1990, 1991; Quaid and Lagerberg, 1992, Sampath et al, 1991; Shirazi, 1994) is that on net, travel and transport emissions are reduced for those who telecommute (not just total travel, but specifically peak-period and auto travel are reduced as well). However, it must be cautioned that the research to date is based on small samples of early adopters, which are subject to selection bias. Generalizing productivity, transportation, and other impacts from these early adopters to the population of potential telecommuters is unreliable.

An important question for transportation planners and policymakers, then, is given that telecommuting appears to have positive transportation/air-quality impacts for those who do it, will enough people ultimately telecommute, often enough, to

make a difference in the aggregate? Put another way, will telecommuting, as an alternate work arrangement, have a broad enough appeal to make it a significant transportation strategy?

Terms such as 'make a difference' and 'significant' are subjective, and whether or not telecommuting is eventually considered a successful transportation strategy may depend largely on one's prior expectations. Our own expectations on the amount of future travel reduction attributable to telecommuting are relatively modest for the time horizon of ten to fifteen years. However, we do not preclude telecommuting from being potentially a significant strategy taken in the context of a menu of mitigation measures, each of which individually may have a small impact, but which collectively can have a substantial impact.

Regardless of one's expectations for the outcome, there is evidently a need for the ability to forecast the demand for telecommuting. Various forecasts of telecommuting adoption and impacts have been developed in the past (Boghami et al, 1991, JALA Associates, Inc, 1983, Nilles, 1988) and used to estimate potential future impacts of telecommuting on vehicle-miles traveled, energy consumption, infrastructure costs, and transportation safety. However, these studies are more accurately characterized as 'potential scenarios' than true forecasts. That is, they are based on the fulfillment of a series of assumptions (for example, if $x\%$ of the $y\%$ of the workforce that is expected to be information workers in the year 2000, telecommutes $z\%$ of the time on average, the impacts will be), without evaluating the likelihood that those assumptions will be realized (Salomon, 1986).

Such scenario building is a useful first step in bracketing the eventual adoption level of telecommuting, especially early in the diffusion process when little empirical data is available. Ultimately, however, the goal is to have a causal model, forecasting the demand for telecommuting as a function of various explanatory factors. That model may then be incorporated into a conventional travel demand forecasting model system, or some other means used to predict the impact of telecommuting on regional travel patterns.

A causal forecast is important beyond providing the ability to determine whether dealing with telecommuting is worth a transportation professional's time. It also should provide the ability to identify and describe meaningful market segments, and a means of assessing the likely effect of various policy choices (public or private) that hinder or stimulate telecommuting. As such, it will provide valuable information both to public policymakers and to private employers considering the implementation of telecommuting. Even if the aggregate amount of telecommuting is not large, it is still worth studying because it provides an opportunity to better understand trip-generation behavior—that is, the decision whether or not to make a trip (Jones and Salomon, 1993).

In this paper an intermediate step on the way to a true telecommuting demand forecast is presented. The goal of the study described here is to develop a behavioral model of the individual choice to telecommute. Such a behavioral model will not itself constitute an aggregate forecast, but will provide a sound basis for the later development of an aggregate forecast. Other efforts are also under way to develop models of telecommuting adoption (Bernardino et al, 1993, Mahmassani et al, 1993, Sullivan et al, 1993).

These efforts are needed because the choice to telecommute is not a simple extension of existing transportation and location models. The alternatives in all such models fulfill the same function (such as, different modes of traveling or different types of residential location). In contrast, the choice to telecommute cannot be viewed merely as a commute mode choice decision. For example, telecommuting is a

multidimensional alternative. Beyond affecting how one gets to work, it affects the way and place that work is done, workplace and household interactions, and so on. As will be seen below, travel issues can motivate a choice to telecommute, but so can a number of other issues. Thus, a conventional travel demand modeling context cannot account for a number of factors important to the adoption of telecommuting. Similarly, the choice to telecommute is not a classic residential or work-location decision, as the choice is usually to telecommute only part time, and again can be motivated by different factors than are included in traditional location models.

The model presented in this paper is grounded in the social-psychological theory of attitude-behavior relationships (Ajzen and Fishbein, 1977), especially as it has been applied to transportation choice decisions (for example, Koppelman and Pas 1980). That is, it is postulated that individual attitudes and perceptions of the objective environment are combined to evaluate each available alternative. The highest-utility alternative is preferred by the individual, but situational constraints may result in a less-preferred alternative being chosen. The conceptual model presented here extends previous models by viewing telecommuting as a multidimensional alternative, by explicitly including the choice-set formation process, and by identifying the role of life-style drives in preference formation.

In the following section of this paper, some key concepts underlying an individual telecommuting choice model are described. In the third section, a conceptual model of that choice is proposed. The final section has a discussion on directions for future research.

2 Key concepts relating to the choice to telecommute

2.1 A brief description of the choice context

The proposed conceptual model of the choice to telecommute is fully detailed in the following section. At this point, however, it is useful to set the stage with a brief description of the choice context, including a discussion of some of the basic terms used in the model. First, a distinction is made between two types of factors in the individual choice process: *constraints* or *facilitators*, and *drives*. We propose the following definitions, each of these terms is elaborated more completely in the following subsections.

Constraint: a factor which prevents or hinders change (in this case, the choice to telecommute) if it is present.

Facilitator, or enabler: a factor which allows change (telecommuting), or makes the change easier or more effective, if it is present. The same basic factor may be either a facilitator or a constraint, depending on whether it is present in a positive sense or a negative one. For example, high cost, managerial disapproval, and unavailable technology are constraints, low cost, managerial approval, and appropriate technology are facilitators.

Drive, or motivator: a factor which actually motivates a person to consider a change (to begin to telecommute).

Note that these terms apply generically to many types of change, the particular change we are interested in here is the decision to telecommute. Thus, we have the following scenario in mind. A person is not telecommuting. He or she is driven to consider telecommuting by one or more of the factors presented below. The presence of facilitators increases the probability that telecommuting will be adopted (or the amount that he or she chooses to telecommute), *given the initial drive to consider it*. Without that drive, facilitators are assumed to have no effect on the adoption of telecommuting. The presence of constraints decreases the likelihood of adoption (or the amount of telecommuting) and, if sufficiently strong, will preclude adoption.

One could also consider the scenario in which a person is telecommuting, and is driven to consider stopping. There can be facilitators and constraints for that decision as well. Although we focus on the more frequent scenario described above, the converse decision is also of interest. The choice model developed here is broadly applicable to both types of decisions.

In the following two subsections we list and discuss major constraints and drives, respectively, for the choice to telecommute. The relationships among facilitators, constraints, and drives will be elaborated more fully in section 3.

2.2 Constraints on choice

In many transportation-related choice models, the role of constraints is minimal. It is often implicitly assumed, for example, that everyone has the same set of alternatives from which to choose (that is, the same 'choice set'). By contrast, in a model of the choice to telecommute, constraints on choice must have a prominent role. Most people currently *do not have the choice* to telecommute.

Thus, a model forecasting the aggregate demand for telecommuting should address the constraints on that demand, the extent to which those constraints are binding now, and the extent to which they are likely to be relaxed in the future. Similarly, a model of the individual choice to telecommute must also meaningfully treat the effect of constraints on that choice.

Key constraints can be categorized as relating to awareness, the organization, the job, and psychosocial factors (see summary list of constraints in table 1). The first three categories contain external factors that are subject to change (for example, by company or public policy, by marketing strategies, or by technological advancements), whereas the other category contains moderating factors that are essentially internal to the individual and are less amenable to external change. The discussion below is oriented toward constraints. Recall, however, that the same factors in opposite forms can serve as facilitators.

Table 1 Summary of the constraints on the choice to telecommute

External	Internal
Awareness-related	Psychosocial
Lack of awareness	Personal interaction needs
Misunderstanding	Household interaction problems
Organization-related	Lack of discipline
Lack of employer support	Risk aversion
Managerial disapproval	Perceived beneficial commute
Job-related	
Job unsuitability	
Unavailable technology	
High cost	

Awareness-related constraints

Lack of awareness Employees will not consider telecommuting if they are unaware of it as an acknowledged work option or are unaware that it is offered by their present employer. Thus, this constraint, if it is present at all, is expected to be binding (though perhaps relatively easily removed).

Misunderstanding Even if awareness of telecommuting is present, it may not be considered a personal option if there are some misconceptions regarding its applicability (for example, if it is believed that it is only for women with young children, or

that it must be full-time or not at all, or that it is primarily for intensive computer users) Unlike awareness, we postulate that there can be degrees of misunderstanding, with a corresponding continuum of impact on the choice to telecommute. If the misunderstanding is severe enough (and negative toward telecommuting), it can act as a binding constraint. Moderate levels of misunderstanding, however, may simply increase or decrease (depending on whether the misunderstanding results in a positive or negative perception of telecommuting) the likelihood of adoption by various degrees.

Organization-related constraints

Lack of employer support At this time, only a small proportion of employers explicitly encourage telecommuting, and many implicitly or explicitly forbid it. This is a major constraint, and one which is more difficult to overcome than lack of awareness and misunderstanding.

Managerial disapproval Even if an employer is generally supportive of telecommuting, individual supervisors within the firm or agency typically have veto power over decisions for staff to telecommute.

Job-related constraints

Job unsuitability Clearly, some tasks are location-dependent, and hence not 'telecommutable'. Extreme examples include trimming hedges, goods delivery, and brain surgery. The difficulty lies in determining whether a job, this is a collection of tasks, is telecommutable, this is likely to be a question of degrees rather than a black or white classification. There are two factors involved. First, many jobs which, on the face of it, appear to be location-dependent, in fact have enough information-related tasks for part-time telecommuting to be perfectly feasible. Thus, the County of Los Angeles telecommuting program includes field workers such as restaurant inspectors and probation officers, and programs in the cities of Los Angeles and Palo Alto include police officers (Jung, 1991)—all of whom perform telephone-based, computer-based, and paper-based work from home (bypassing the trip to 'check in' at the main office) but still spend the requisite time in the field.

Second, even the determination of what is a location-dependent task will change with advances in technology. For example, computers and telecommunications make possible the remote troubleshooting of system malfunctions, whereas formerly such an activity would require the on-site presence of a technician. Computers are already running assembly lines and assisting in microsurgery, so it is likely that future technological developments will enable many more tasks to be performed remotely than are now thought possible. What technology makes possible and what fits social, psychological or business needs may not be the same thing, of course. The point is that the flexibility is or will be there, to be utilized or not as those needs dictate. Thus, the job title alone tends not to be a reliable indicator of job telecommutability. What is important is knowing the content of the job, and how location-independent various tasks that make up the job are now and are likely to be in the future.

Unavailable technology As indicated earlier, not all telecommuting requires sophisticated technology. However, some jobs involve the use of advanced technology (such as, computer-aided design/manufacturing equipment, high-speed data transfer capability, and videoconferencing or other high-bandwidth applications) to the extent that it may be considered essential to effective telecommuting. If it is impossible or too expensive to provide such technology at the home or other remote location, the ability to telecommute is impaired for those employees.

High cost Prohibitive financial costs can constrain an individual's decision to telecommute, even for low-tech applications. If a person's job involves making numerous toll calls, and the employer will not pay for such calls made from a remote worksite, the employee is less likely to telecommute. Another cost-related constraint is the lack of appropriate space at home.

Psychosocial constraints

Personal interaction needs This may include the desire for interaction with specific people at the primary worksite (whether social or professional), the general expectation of more fulfilling social and/or professional interaction at the primary worksite, and the desire to 'see and be seen' (for example, dressing up, recognition of a presence), even if no verbal interaction takes place.

Household interaction problems This factor may be a constraint on the choice to telecommute from home, but theoretically should not affect the choice to work from a telecommuting center. Potential problems include distractions by other household members, and conflicts with other household members.

Lack of discipline This factor has several aspects. Some people find it difficult to work in the absence of the traditional cues of time, place, and supervisor presence, for some, it would be too much trouble to remember what materials to bring back and forth between the primary and the remote workplaces, and for some, the danger of overeating, smoking, or substance abuse is higher without the social conditioning offered by the conventional work environment [a few people have decided to quit telecommuting after gaining too much weight (Edwards and Edwards, 1990, Phelps, 1985)]. This aspect is also more likely to apply to home-based telecommuting than to the center-based form.

To the extent that people acknowledge (a) that they possess one or more of these characteristics, and (b) that possessing those factors makes them ill-suited to telecommute, they are less likely to choose to do so.

Risk aversion This may manifest itself as a specific concern, such as visibility for career advancement. In a recessionary economy one may want to avoid the visibility associated with seeking to telecommute, as it may jeopardize one's position. Or, there may simply be a general feeling that 'if it ain't broke, don't fix it', that is, a desire to maintain the status quo.

Perceived beneficial commute Many people actually derive some utility from the journey between home and work. The temporal and spatial separation serves as a buffer zone between two realms of life which many prefer to keep somewhat distinct (Richter, 1990, Shamir, 1991), or the time spent commuting may be used in some productive way such as reading, making phone calls, listening to music or educational tapes, or simply being alone with one's thoughts—for some people, it is nearly the only opportunity to do so (Salomon, 1985).

2.3 Drives to choose telecommuting

The role of constraints is an important one in the individual decision whether or not to telecommute, but it by no means tells the whole story. A person does not telecommute simply because the technology is available, or because the boss says it is okay. Those factors facilitate telecommuting but do not drive it. Conversely, a person can want to telecommute even though the supervisor forbids it; that prohibition is a constraint preventing a desired choice.

There is an identifiable core of people for whom none of the constraints discussed in the previous subsection is binding. That is, they are aware, understand,

have supportive employers and supervisors, suitable jobs, appropriate technology at a reasonable cost, and favorable psychosocial characteristics. Yet within that core of people, not everyone will choose to telecommute. Focusing on that unconstrained core, and attempting to determine why those people are motivated to consider telecommuting or not, provides insight into what the drives are.

Salomon and Ben-Akiva (1983) identify three major 'life decisions' that determine a person's life-style: participation in the labor force, formation of a household, and orientation toward leisure. These major choices provide the basis for many smaller decisions, including, in our context, the choice to telecommute. Thus, we propose that three types of drives to telecommute include factors that are work or career, family, and leisure related. To those three we add two more: ideology, and travel. (There are a number of additional advantages to telecommuting, such as the elimination of the need to dress up, that function more as side benefits than as drives.)

By ideology, we mean a person's commitment to one or more 'causes' (such as environmental, religious, philanthropic). It is expected that such an orientation will affect the way time is allocated, as well as other decisions. In particular, a strong concern for the environment may motivate some people to telecommute to save energy and improve air quality.

Travel is considered a drive, again partly because it affects the way time is allocated. Time spent traveling reduces the time available for fulfilling other drives, and the generalized cost of traveling (time, money, and psychological cost) is a measure of the ease of moving between activities. The expectation is that if travel is a drive to telecommute, in most cases it will operate in the direction of a desire to reduce travel.

The drives to telecommute are summarized in table 2. People may generally possess all five types of drives to varying degrees. In the discussion below, note that drives are fundamentally personality based. People possessing the same objective characteristics may still be differently driven. For example, one person with two children may be family driven, while another person also having two children may not be. It is the internal reaction to the external situation that is important, not the external situation itself.

Table 2 Summary of the drives to telecommute

Work related	Ideology related
Workplace	Environmental
Independence	Travel related
Family related	Commute
Leisure related	Mobility limitations

Work related drives

Workplace related These types of factors include the desires to get more work done (which may be expressed not only by the workaholic who is driven to put in longer hours, but also by the conscientious employee who just wants to be productive during regular hours and finds it difficult to do so because of the distractions of the main workplace), to reduce stress engendered at the main workplace (perhaps because of personality conflicts, a high-pressure atmosphere, competition for scarce resources, or the distracting environment mentioned above), and for more control over the physical work environment [there may be more space or more-attractive or more comfortable surroundings at home; for some, the ability to smoke freely at home is a strong factor, others may be allergic to elements in the conventional workplace (Hafer, 1992, appendix D)]

Independence This category includes the following personality traits which, if strong enough, may motivate a person to telecommute initiative (the desire and ability to work as a salaried employee, but largely free of supervision); or entrepreneurship (the desire to be in business for oneself, which may be facilitated by the flexibility offered by telecommuting)

Another set of personality traits related to independence, but not necessarily work related, involves antisociability (the desire to avoid people), which may be due to introversion (shyness, fear of people) or misanthropy (dislike of people) In a small fraction of cases, one of these traits may be sufficiently strong to motivate the desire to telecommute

Family-related drives

These would include the desires to spend more time with one's family, or for more flexibility in arranging one's time—in particular, the need for flexibility in handling dependent (child, elder, or disabled person) care

Leisure-related drives

Similarly, these include the desires for more time for oneself, or more flexibility in arranging the time one does have, perhaps to pursue a specific interest, hobby, or avocation Education, exercise, and other personal improvement activities are also included

An ideology-related drive—environmental

For perhaps a small but key group of people, the desire to help the environment by driving less is a major reason to telecommute

Travel-related drives

Commute These types of drives include the perception of having a long commute, a burdensome commute (for example, because of congestion or multiple mode changes), or an expensive commute (likely to increase in importance as congestion pricing and parking pricing policies become more common)

In some short-term instances (such as during the Spring 1992 riots in Los Angeles), the perception of having a dangerous commute may also be a factor In other emergencies (such as the October 1989 Loma Prieta earthquake which damaged a number of major highways in the San Francisco Bay Area) it may be physically impossible to commute In still other instances (such as the April 1992 Chicago Loop flood and the February 1993 New York World Trade Center bombing), the workplace itself may be temporarily closed down as the result of unforeseen circumstances Although they are not the primary focus of this research, the motivation to telecommute in these ad hoc situations should not be overlooked

Mobility limitations These factors include the desire to work while temporarily disabled (for example, following surgery, or a broken leg), permanently disabled, or otherwise on parental leave (that is, partially combining work with taking care of a new child, in lieu of taking paid or unpaid leave and not working at all for some length of time)

2.4 Discussion

In section 2.1, we pointed out that the same factor may be *either* a constraint or a facilitator Here, it should be noted that, although there is a conceptual distinction between constraints and drives, the same factor may serve as *both* a constraint and a drive, sometimes simultaneously For example, a family-driven person may want to telecommute to have more time to spend with the family, but feel constrained from home-based telecommuting because of distractions by those same family members

Another example as the result of personality differences, a certain commute may be considered a drive to telecommute by one person (because of its stressfulness), whereas the identical commute may be considered a constraint on telecommuting by another person (because it performs a beneficial function) And, of course, the same general type of factor can act in one way in one situation and another way in another setting One company may forbid telecommuting outright, thus imposing an organizational constraint In another company, telecommuting may be promoted so zealously, creating management and peer pressure to participate, that the work-driven employee will be motivated to choose to do so Thus, in designing an instrument for collecting empirical data on the choice process, special care should be taken to permit these distinctions to be made For example, different questions will determine whether family concerns are a drive, a constraint, or both

Further, as mentioned earlier, one can also examine the choice to stop telecommuting, and the same types of drives and constraints are likely to apply To take a complicated but not farfetched example John is motivated to telecommute to have more time to spend with his family, but fears the distractions from family members That constraint is outweighed by other considerations, however, so he begins to telecommute Soon, he realizes that those distractions are serious enough to impair his productivity and are causing family conflicts, so for work and family reasons he is motivated to stop telecommuting He is constrained from doing so, however, by the fact that meanwhile his wife has started working, and he is needed to take care of their young children when they arrive home from school

John's decision now cannot be treated independently of previous decisions he has made This implies that the history of an individual should be considered when evaluating his or her choice behavior

Why is it important to distinguish between constraints and drives? One reason is that to the extent that telecommuting is considered a useful transportation strategy, policies supporting telecommuting are being and will continue to be developed These policies are likely to include measures to remove or reduce external constraints and /or to enhance facilitators It will then be desirable to be able to predict the impact such policies will have on telecommuting If it is (falsely) assumed that the presence of constraints (or the lack of facilitators) is the only thing preventing people from telecommuting, then the effect of removing those constraints (or providing those facilitators) will be overestimated

Finally, it is worth pointing out that transportation-related and environmental factors are only some of the many types of reasons people may have for telecommuting, and may not even be the most important ones This alone does not lessen the usefulness of telecommuting as a transportation strategy, because the presumed transportation benefits will occur regardless of why people are doing it However, it does have implications for the design of policies intended to promote telecommuting Transportation-oriented policies may be less effective than expected And if, for example, an important reason for telecommuting is to reduce the distractions of the workplace, then a telecommuting center that replicates the conventional open-office floor plan may not be very attractive to prospective telecommuters

Most people are driven by a combination of the five types of factors identified above However, those factors will be weighted differently for different people In empirically operationalizing the conceptual model presented here, it will be important to identify various life-style segments of the population, estimate the sizes of those segments, and understand how they differ in terms of attitudes, propensity to telecommute, and sociodemographic characteristics

3 A conceptual model of the choice to telecommute

Telecommuting offers an option to improve one's well-being or, in some cases to worsen it. An individual is assumed to weigh the pros and cons and to choose whether or not to telecommute on the basis of his or her assessment of these. It is plausible to assume that the choice involves some trade-offs between those factors which support telecommuting and those which decrease its utility to the individual.

As an approach to understanding the decision process, we suggest the following structure, depicted in figure 1 (Salomon, 1991). An individual is exposed to an environment which defines the context within which one can act. It includes the following facets: institutional, social/cultural, technological, physical, and economic. The individual is also subject to numerous constraints, some of which are long term or permanent and others of which may be temporary. Given the environment and the constraints, the individual, shown as a 'black box', makes a choice which can be observed by the researcher.

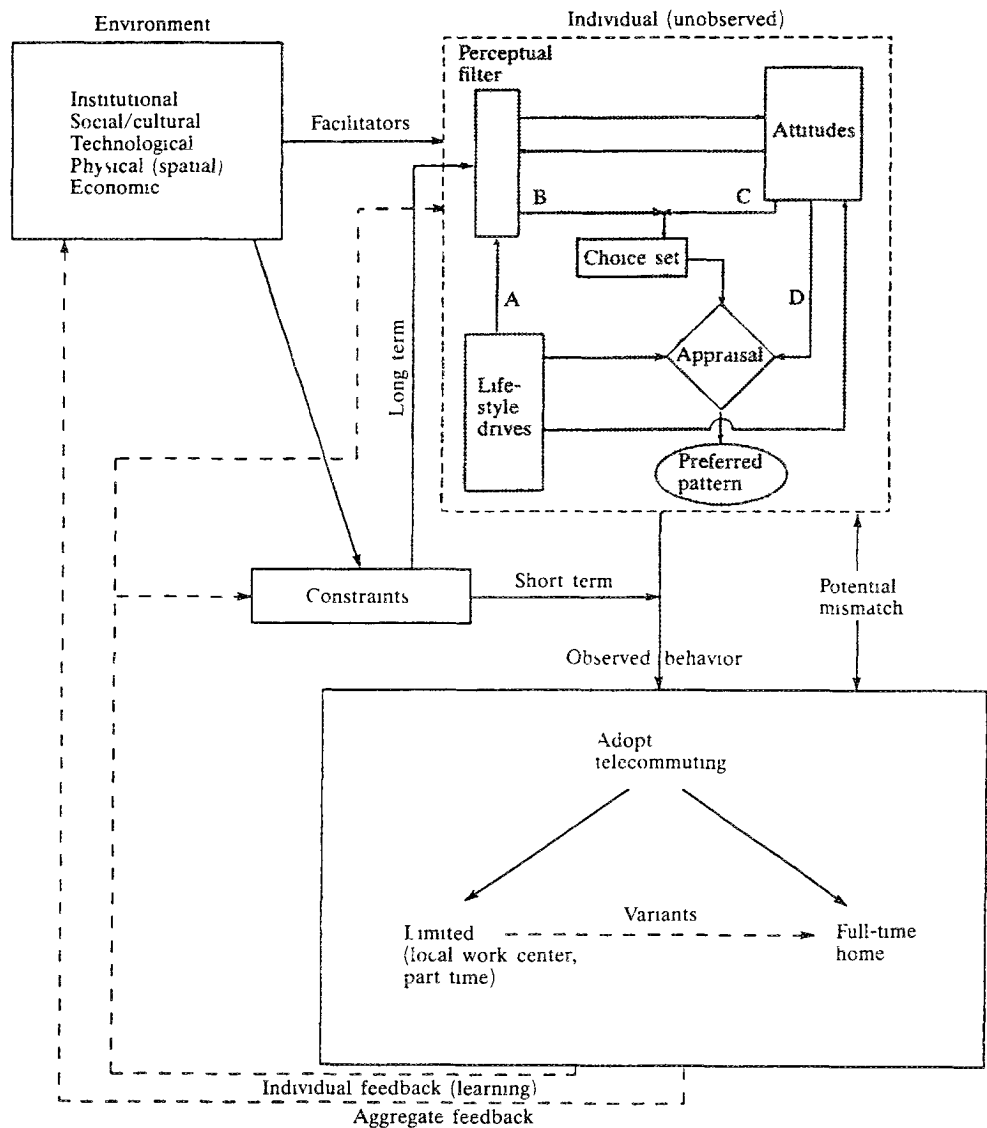


Figure 1. A schematic model of the telecommuting decision context

There is a dynamic aspect to this structure, as indicated by the dashed arrows in figure 1. Actual behavior provides experience and new information which may lead to an alternative choice when the situation arises again. The feedback mechanism acts on all elements described above. The changes in many individuals' behavior may change the environment. For example, telecommuting may become more acceptable to managers if many people do it. The feedback may change the constraints and it may affect the individual's perception of the options.

3.1 The components

Our major objective is to penetrate the black box and suggest a plausible explanation for the process occurring there. The black box, it is hypothesized, consists of five relevant entities, shown schematically in figure 2. For the sake of simplicity we have omitted the arrows indicating the underlying dependence among perception, attitudes, and life-style preference which are shown in figure 1. Each of these affects, and is affected by, the other two. For example, the nature of the filtering effect of the perception mechanism depends on prior attitudes, and vice versa. Attitudes are constructed by the information perceived. Below we discuss each component that is hypothesized to play a role in the process. In section 3.2 we describe the process itself.

The *perceptual filter* acts on the information received from the environment. The filter may block some information altogether, or may distort information that is entered. The output of the filter is a cognitive map of the environment, in terms of facilitators, constraints, and views thereof, which may or may not correspond to what the researcher defines as the 'objective environment'.

Attitudes are a set of dispositions regarding various aspects of behavior, and may be viewed as translators of information. Two types of attitudes are identified: cognitive and affective. *Cognitive* attitudes are 'facts', as viewed by the individual. For example, travel time may be distorted upwards or downwards by the individual. The travel time registered in one's cognitive map is a product of information received from the environment, and the cognitive attitude. Thus, one could suggest that any information item stored in a person's mind is indexed with some cognitive attitude. *Affective* attitudes express the individual's (dis)likings. For example, two individuals exposed to similar work environments may differ in their feelings: one may value the interaction it offers, the other may feel it is too distracting.

The *choice set* comprises those options recognized by the individual as possible, not necessarily desired, courses of action. It is a subset of the 'universal set' of alternatives, which includes all possible alternatives available to a group of individuals.

Salomon (1991) proposed a universal set of alternatives that may be adopted to cope with congestion. Here, we expand the universal set to include the likely potential responses to all of the five types of drives identified above. This universal set is presented in table 3, where the options are arranged roughly in order of increasing transaction costs (that is, in increasing complexity of implementation). In the table, a '●' means that the choice in the corresponding row is a potential response to the drive in the corresponding column. The last column is specifically focused on the ideological drive considered most relevant to telecommuting environmentalism.

By design, telecommuting is a potential response to each of the drives. However, each drive may generate consideration of many other alternatives as well. Thus, an individual's decision to telecommute or not should be examined in the context of what drive(s) it is intended to satisfy, and what other alternatives the individual perceives for satisfying those particular drives.

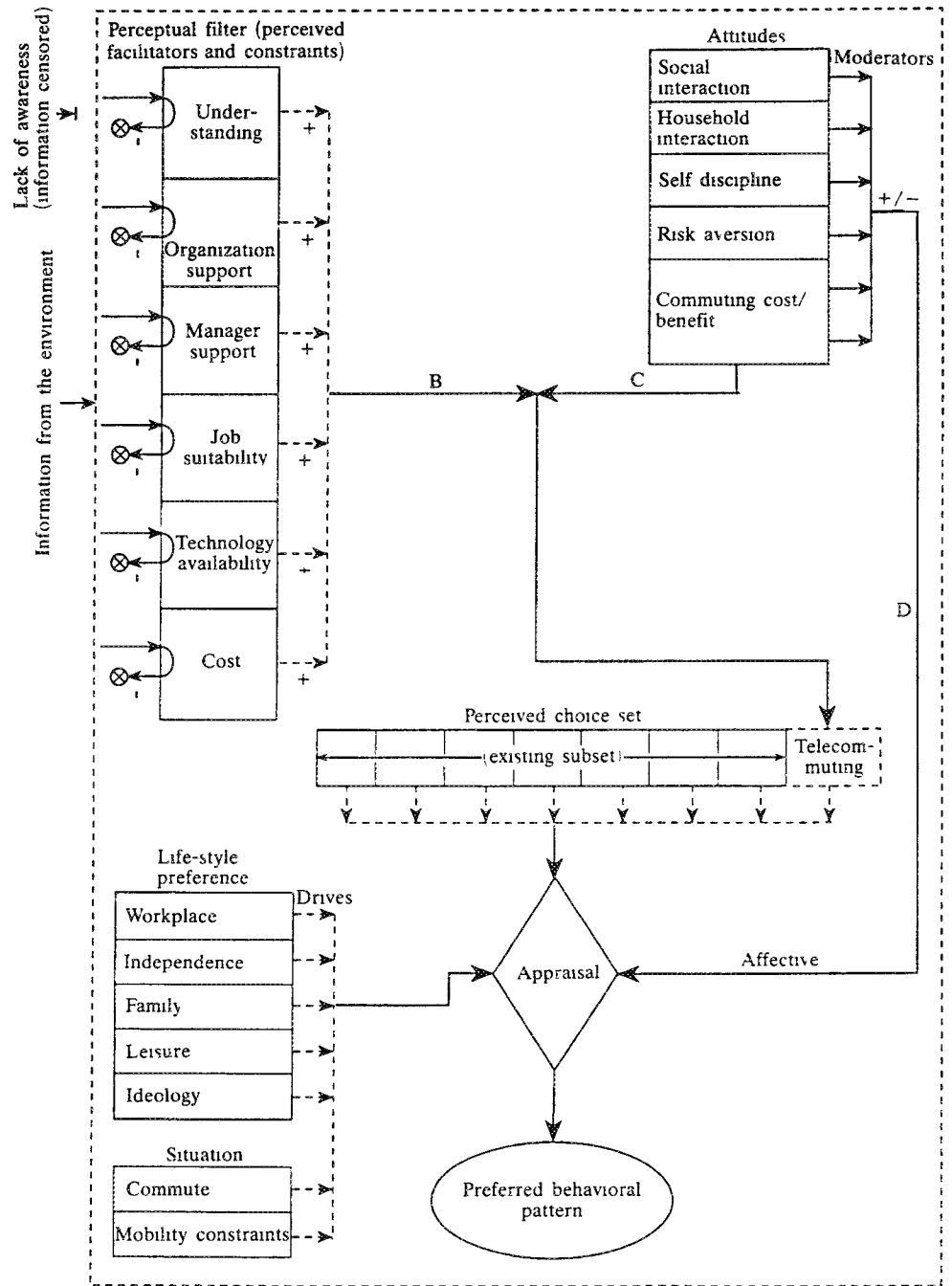


Figure 2 A schematic model of the internal decisionmaking process

Life-style preference is the (very) long-term preference an individual has formed with regard to three main aspects of life work or career, household, and leisure (Salomon and Ben-Akiva, 1983) In addition, life-style also involves ideological convictions, which may or may not be binding in terms of their effect on short-term decisions

A life-style an individual aspires to maintain can be viewed as a 'policy' which guides his or her short-term decisions. That is, behavioral options will be tested against the life-style choice and the extent to which they concur with these long-term preferences. The actual choices may depart from the life-style policy, because of short-term constraints or other short-term contextual factors (for example, impulse shopping) but in general we expect coherence between the short-term and long-term choices.

In figure 2 we have included two situational factors which are not actual life-style components but are long-term preferences closely knit with life-style. The first is the commute and the second are mobility constraints. An individual may view commuting as a burden as it negatively affects the time left for other life-style preferences, or alternatively, the commute may be desired as it serves as a buffer between activities. Similarly, mobility constraints may create long-term preferences with regard to certain types of activities.

Preferred behavioral patterns are a set of behaviors which remain at the end of the screening by the previous four elements. This subset of options is congruent with the life-style preferences, it is acceptable (and even desired) by the individual's attitudes and, of course, it is within the choice set identified by the individual. In the absence of constraints (or impulsive responses), the actual observed behavior will be identical to the preferred behavioral patterns.

Table 3. The 'universal' choice set - adaptive responses to life-style-related drives

Choices	Drives				
	travel	work	family	leisure	environmental ideology
Accommodate travel costs	●				
Reduce travel costs	●			●	●
Socialize at work				●	
Change work trip departure time (unofficially)	●	●	●		●
Work unpaid overtime		●			
Take work home		●	●		
Change route	●				●
Buy time		●	●	●	
Adopt flextime	●		●		●
Adopt compressed work week	●		●	●	●
Change mode	●			●	●
Invest in productivity-enhancing technology at home	2nd order		●		●
Telecommute from home (part or full time)	●	●	●	●	●
Telecommute from a local work center (part or full time)	●	●	●	●	●
Change to a new job in a new location	●	●	●	●	●
Change to a new job in the same location		●	●	●	●
Relocate home	●	●	●	●	●
Change from part-time to full-time work		●	●		
Change from full-time to part-time work	●		●	●	
Start a home-based business (or put more effort into an existing one)	●	●	●		
Quit work	●		●	●	
Divorce family		●			

● = potential responses

3.2 The process

Our conceptual model investigates how constraints and drives are processed in the black box, assuming that the above five elements (the perceptual filter, attitudes, the choice set, life-style preferences, and preferred behavioral patterns) are at work. The model is described in figure 2.

An individual may be in one of two initial states. The first is that of satisfaction, where the activity patterns correspond to the preferred behavioral patterns and this is a steady state for the individual. The preferred behavioral pattern may not be exercised in all situations, because of short-term constraints, but in the absence of such constraints, the revealed behavior would match the preferred pattern. In this case, the individual is not interested in changes and hence is not actively searching for alternative options.

The second state is that of dissatisfaction with one or more aspects of life-style, as they pertain to time-space behavior. Insufficient time for the family, too much time spent in commuting, a desire to see more (or fewer) people, and many other examples can be given for aspects with which one may be dissatisfied. In this case, it is plausible to assume that the individual is searching for means to improve his or her state, or at least is open to offers of such options. In the following suggested process it is assumed that the individual is in the latter state, namely, looking for some change to improve his or her situation.

Drives are the stimulants that initiate the process of deliberations about change. This process leads to an active search for alternatives (arrow A in figure 1), and the generation of the choice set (arrows B and C). Note that the choice set may or may not contain telecommuting. Options other than telecommuting are likely to be considered in the same manner. In the absence of drives, an individual will not consider telecommuting. Drives emanate from life-style preferences. A person aspiring to fulfill some long-term objectives may seek alternatives which will reduce the dissatisfaction with the present situation.

Any single drive can initiate the process and it is a necessary condition that at least one drive is active. If more than one drive is activated, the motivation for adopting a change is likely to be stronger. Once a search mode is activated, information from the environment is recognized and registered. Some information may be incumbent in a perceived choice set, where it has been 'stored' since an earlier experience or through passive information accumulation (Salomon and Koppelman, 1992). New information is actively sought once a drive has been activated. Figure 2 demonstrates only how the information about telecommuting is filtered in, so that this option is added to or rejected from the perceived choice set. Similarly, information about other alternatives is absorbed.

The perception mechanism acts as a filter which may eliminate the option to telecommute, on the basis of lack of awareness or misunderstood information. The individual is exposed to a wide range of information flows from the environment. Depicted in figure 2 is only that information which pertains to telecommuting. Information flowing from the environment concerning institutional and supervisor's support (or lack of support), job suitability, and technological capacity and costs, is received by the perceptual filter.

For telecommuting to be considered (that is, to be included in the choice set), the information about the viability of this option must enter the cognitive map. Specifically, all the constraints identified above must be nonbinding (that is, above some threshold value). If one or more of the constraints shown in table 1 is binding, telecommuting will not be further processed and will not become an option in the individual's choice set. This situation is depicted in figure 2 by the arrows

pointing to the ⊗s, representing the case where certain information may construct a barrier against telecommuting

The nature of the filtering is affected by the attitudes the individual holds. As noted above, attitudes serve as translators of objective information to fit in the individual's cognitive map. Attitudes may cause information to be registered in a biased or distorted form. In extreme cases, if the individual has a very negative attitude concerning one or more of the attributes of telecommuting, the option will be eliminated before it was ever recognized in the choice set. For example, if the individual believes that the tangible or intangible costs of telecommuting are prohibitive, then the process of considering the option will be halted.

The information filtered in generates a new alternative in the choice set. The values of the attributes of this alternative are moderated by the cognitive attitudes shown by arrow C in figure 2.

If the perceived choice set is a nonempty set, and at least one drive is activated, the individual may begin to deliberate on whether or not to adopt a change. In the choice set, there are a number of options, one of which is telecommuting. The alternatives differ in the extent to which they fulfill the individual's objectives and they differ in the generalized costs of adoption as perceived by the individual.

The next stage is the appraisal of the alternatives. Each alternative is evaluated against two sets of screens: the extent to which it fulfills the objectives defined by the drive, and the extent to which it is congruent with the attitudes held by the individual. Here, the affective attitudes or feelings, shown by arrow D in figure 2, come into play. If the alternative fails to fulfill the drive, it is likely to be eliminated. However, the attitudes may play a weaker role. It is possible that they are moderators which affect the relative weight the individual assigns to various attributes of the alternative.

The appraisal of the benefits and costs of adoption involves a trade-off between various attributes of each alternative. Thus, for the present research, we postulate a compensatory utility maximization framework for understanding the appraisal and choice process. Noncompensatory utility frameworks (see Gregson, 1963, Tversky, 1972) may also be suitable approaches, this is a fruitful direction for future extensions of this research. In either framework, the individual adopts as the preferred behavioral pattern that alternative which provides maximum utility. We assume that when deciding to telecommute, a person simultaneously chooses a frequency level (such as once a week). Subsequent decisions may be to alter the frequency but not necessarily quitting telecommuting, or to quit telecommuting temporarily.

The utility maximization concept implies that the chosen alternative is the form of behavior desired by the individual, taking into account the transaction costs. However, the observed behavior is likely to demonstrate a range of patterns which differ from the preferred behavior. This deviation or mismatch is explained by the presence of temporary constraints, which eliminate the 'best' alternative and require its replacement by a second-best choice.

Feedback or experience, shown by the dashed arrows in figure 2, plays a major role in affecting the decision. Therefore, it is very important to note the dynamics of the process and to identify the individual's location in the time dimension (see discussion below). Individuals do not enter the process from a vacuum state. Each has some experience in, for example, coping with congestion. Consider two individuals who have a choice set consisting of the do-nothing option plus two new alternatives: changing their departure times and telecommuting. For one, changing the departure time may be a low-cost option, which is believed to reduce congestion costs.

The other may already have experimented with such changes, so that any additional change involves high costs (for example, leaving before the family breakfast) or knowledge that only a marginal benefit can be realized through yet another change in departure time. Thus, the first person is less likely to adopt telecommuting, whereas the second, for whom family is obviously an active drive, is more likely to telecommute.

The information gathered by experience feeds into two elements in the black box. It is part of the input information that, through the process of perception of the environment, is entered as attributes of the perceived choice set. It also affects the attitudes. In the case of perception of the environment, it is important to note that the weight assigned to information gathered by experience is often greater than that assigned to other sources of information.

It is important to consider the temporal location of the individual vis-à-vis his or her former experience. Individuals may be altering their behavior at different paces, in response to changing conditions. Assume that the individual is facing growing congestion which increases his or her dissatisfaction, as shown in figure 3. Small incremental changes in travel time are not likely to affect behavior. However, at a certain point, a consideration of change is likely to be triggered. If a change is adopted, which in fact improves the individual's situation, the dissatisfaction is lowered (point A in figure 3) and the process begins again. When a threshold level of dissatisfaction is reached again, the choice set considered will differ from that considered at point A. The challenge is to obtain information on the location of the individual along this temporal dimension. Simply asking about previous changes may not prove fruitful, as those may have been adopted under very different circumstances.

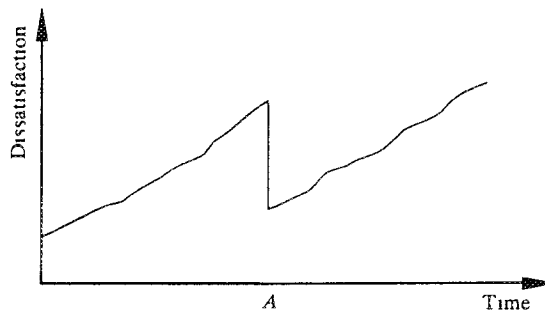


Figure 3. The temporal dimension of the choice process.

4 Summary and directions for further work

In this paper we have presented a conceptual model of the individual decision to telecommute. Key elements of that decision, including constraints, facilitators, and drives, are defined and the relationships among them described. The major types of constraints (if negative) or facilitators (if positive) include external factors related to awareness, the organization, and the job, and internal psychosocial factors. The major types of drives are work, family, leisure, ideology, and travel.

It is argued that the absence of constraints is a necessary but not sufficient condition for an individual to telecommute. The presence of one or more drives, assumed to be associated with some dissatisfaction, is necessary to activate the search for a solution to that dissatisfaction. Thus, policies directed at the removal of constraints will presumably stimulate the adoption of telecommuting, but not to the degree expected if drives are not present or are not satisfied by the telecommuting alternative.

The choice set contains those alternative solutions perceived to be feasible by the individual. It may or may not contain telecommuting (depending on whether all constraints are nonbinding or not), and probably contains other alternatives having nothing to do with telecommuting (see table 3). Each alternative is evaluated in terms of how effectively it satisfies the drive, and the individual's attitudes toward it. The alternative (or bundle of alternatives) which maximizes individual utility becomes the preferred behavioral pattern. However, short-term constraints may prevent the preferred behavior from being exercised. The process is a dynamic one, in which previous choices affect attitudes and constraints and alter drives. Ideally, the individual should be studied in the context of past decisions.

Work directed by the authors is under way to operationalize the conceptual model presented here, including the quantification of the hypothesized relationships. A questionnaire has been designed to obtain data on the components of the model, and responses have been collected from more than 800 individuals. Probabilistic discrete-choice models (Ben-Akiva and Lerman, 1985) of the decision to telecommute are being developed, whose explanatory variables include measurements of drives and facilitators or constraints. Given the presence of one or more drives, the probability of a choice to telecommute will increase with the number and strengths of drives and facilitators present and decrease with the number and strengths of constraints present. The findings of this empirical evaluation will be reported when they are available.

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