Conceptual Framework To Study the Effectiveness of Employer Trip-Reduction Programs

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Policy makers throughout the United States increasingly rely on employer-sponsored trip-reduction programs to reduce air pollution and traffic congestion. Despite the popularity of these programs, only a small number of studies have been undertaken to evaluate their performance. This paper presents a conceptual framework for a more rigorous study of employer trip-reduction programs and their expected emission and traffic reduction impacts. Implications of the practical application of the framework and data requirements are also discussed.

The number and variety of government mandated trip-reduction programs have increased significantly during the last 10 years. This trend reflects a growing recognition by policy makers that trip-reduction programs do work and that they are more likely to be implemented if required by law. A recent survey conducted in the San Francisco Bay Area indicates that the majority of employers who have implemented trip-reduction programs have done so to comply with government regulations (*1*). Limited evidence suggests that trip-reduction programs are more effective when initiated through government regulation than through private voluntary participation (*2–4*). Policy instruments, such as local ordinances and regional rules, provide overall direction to these programs by identifying program goals and objectives, issuing administrative guidelines to ensure uniformity in program development and implementation, establishing performance standards, and outlining specific actions to enforce compliance and prevent early program termination.

Federal and state air quality and congestion management legislation has helped accelerate the growth of employer trip-reduction programs. Under federal and some state rules, urban areas that fail to meet air quality and mobility standards are required to control the number of vehicle trips and vehicle miles traveled (VMT). As of 1990, 52 active and proposed trip-reduction ordinances had been identified in six states; 42 of them had originated in California (*5*). The 1987 regional ridesharing rule adopted by the South Coast Air Quality Management District (SCAQMD), the air pollution control agency responsible for improving air quality in Los Angeles, Orange, and Riverside counties and the nondesert portion of San Bernardino county, is the first regional regulatory program of its kind in the United States. This regional rule, known as Regulation XV, directs employers with 100 or more employees at a work site to develop and implement trip-reduction programs for employees arriving to work between 6:00 a.m. and 10:00 a.m., Monday through Friday. Employers subject to Regulation XV must file a trip-reduction plan with SCAQMD every other year. To be approved, the plan should have the potential to attain a policy-prescribed average vehicle ridership (AVR), which may range from 1.75 passengers per vehicle in downtown Los Angeles to 1.3 in sparsely populated areas of the South Coast Air Basin (SCAB).

In spite of the increasing popularity and applicability of employer trip-reduction programs, the evaluation of these programs remains scarce. Evaluative studies conducted to date are primarily descriptive, rely heavily on data from case studies, and place too much emphasis on outcome indicators, such as the number of trips reduced and modal shares (*6,7*). With the exception of work by Giuliano et al. (*8*), little effort has been made to systematically analyze the relative effects of various trip-reduction strategies while controlling for confounding factors (*4,9*). From a policy perspective, the most significant shortcoming found in the literature is the lack of a formalized conceptual framework linking the context and constraints of employer trip-reduction programs with expected outcomes. Thus, given that these programs are not implemented in a vacuum and that they constitute a first attempt to change driving behavior on a large scale, a more comprehensive research approach should be used to assess their effectiveness.

OBJECTIVES

An attempt is made in this paper to provide a minimum conceptual framework that may be helpful for a more rigorous study of employer trip-reduction programs and their expected emission and traffic reduction impacts. On the basis of ridesharing research conducted in the past, the major components and variables of the framework are outlined and the relationship between them is suggested. The proposed framework should improve the understanding of the relationship between program outcomes and the determinants of such outcomes and how the determinants of the outcomes relate to one another and to the desired objectives. Such an understanding may provide fertile ground for more effective public action. In addition, the empirical validation of some of its components should be useful in (a) identifying effective program options, (b) assessing the potential of alternative trip-reduction plans, and (c) determining which strategies work best in different environments.

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METHODOLOGY

In the evaluation of public programs, two types of variables must be considered: (a) outcome variables, which are output-type indicators or dependent variables, and (b) independent or analytic variables, including program or policy variables, which can be manipulated by decision makers, and antecedent or control variables, which represent the context and constraints of the program (*10,11*). An understanding of the role of these variables is essential to maximizing program impacts.

In this paper, the trip-reduction literature, especially as it applies to factors affecting ridesharing behavior, will be placed within the research perspective outlined previously. Many of the variables included in the framework have been identified in the work of Kuzmyak and Schreffler (*7*); Wachs (*12*); Hwang and Giuliano (*13*); Lopez-Aqueres, Siwek, and Peddada (*14*); Stevens (*15*); Bhat, Schofer, and Kopelman (*16*); and the Urban Mass Transportation Administration (UMTA) (now FTA) (*6*). The discussion, however, does not rely on an exhaustive review of the literature. Summarizing all the relevant work here would be a difficult undertaking and would obviously make this paper deviate from its main purpose.

OVERVIEW OF THE FRAMEWORK

The basic components of the framework are (a) public policy, (b) employer factors, (c) travel mode characteristics, (d) employee attributes, (e) employee mode choice, and (f) program impacts (Figure 1). In general, independent variables are found in components (a) through (d). Dependent variables are included in components (e) and (f). According to the hypothesized causal links depicted in the model, independent variables can assume a dependent role as well. Program and antecedent variables are identified with the letters P and A, respectively.

Public policy may affect the performance of trip-reduction programs indirectly by influencing employer factors (e.g., program options), travel mode characteristics (e.g., cost), or employee attributes (e.g., household income). Employer factors include program resources (i.e., company revenues diverted to implement the trip-reduction plan), management commitment, program options (i.e., trip-reduction strategies incorporated into the plan), labor-management agreements, work site location, and employer size, as measured by the number of employees. Employee attributes include personal values (e.g., altruistic feelings), occupation, commuting distance, and household characteristics.

The next framework component is travel mode characteristics. As hypothesized in the model, this component determines employee mode choice and program outcome. Travel behavior theory indicates that the cost, travel time, convenience, comfort, privacy, and safety associated with each commuting alternative are of much concern to the employee and to most travelers in general (*12*). As shown in Figure 1, changing travel mode characteristics is an intermediate but fundamental step to influence employee mode choice and program outcome. Employers must rely on their trip-reduction plans to change travel mode characteristics and, ultimately, employee modal choice.

Employee attributes and mode characteristics jointly determine employee mode choice. The various modes identified

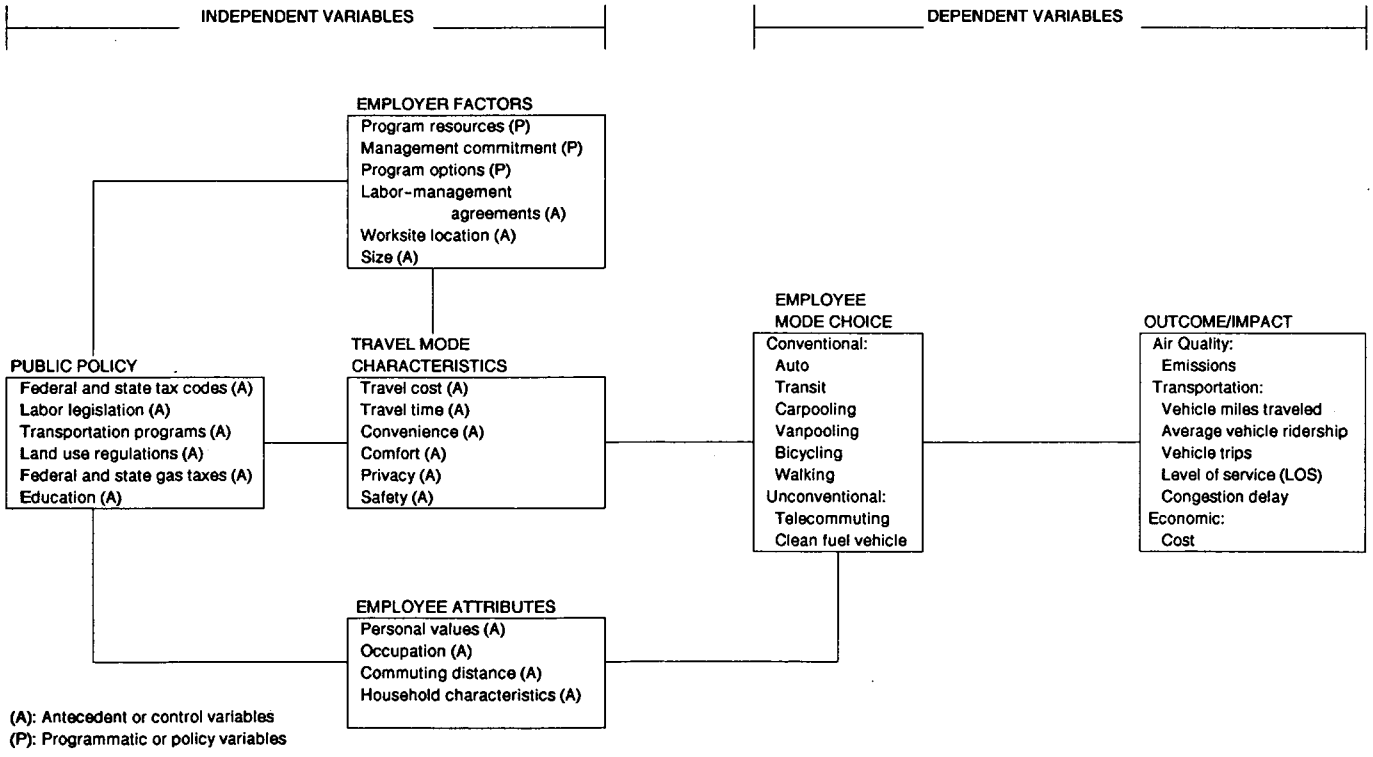

FIGURE 1 Framework to study the effectiveness of employer trip-reduction programs.

in the framework incorporate conventional (e.g., transit) and unconventional (e.g., telecommuting) forms of commuting to work.

The last framework component is the outcome of the trip-reduction program, which depends directly on mode choice and indirectly on the remaining components of the framework. Which particular component, or variables, may exert the greatest influence on modal choice and, ultimately, on program performance, is an important policy question that has to be settled on empirical grounds.

CONCEPTS AND VARIABLES

Public Policy

Specific public policies or government regulations that can have a significant impact on program outcomes include federal and state tax codes, labor legislation, transportation programs, land use regulations, federal and state gasoline taxes, and education. These variables provide the policy context within which the trip-reduction program is implemented.

Federal and State Income Tax Codes

Some specific aspects of the federal tax code promote driving alone while discouraging the use of public transportation. This situation is a result of the way in which employee benefits have been taxed for individual and corporate taxpayers. Until recently, federal regulations exempted employee parking benefits from personal income taxation and allowed businesses to claim the cost of employee parking as a tax deductible business expense. In contrast, employee transit subsidies exceeding $21 per month were subject to income tax (*16*). As a result, employers have favored paid parking over transit subsidies.

Recent federal legislation, however, has raised the transit subsidy exempt from personal income taxation from $21 to $60. The 1992 Comprehensive Energy Policy Act allows employers to provide employees with a nontaxable $60 per month subsidy for the use of public transportation or vanpooling, with an inflationary adjustment allowed every year. In addition, it limits the amount of employee parking that employers may claim as a business deduction to $155 per employee per month. This new policy reduces the cost of public transportation and vanpooling, as well as the employer's incentives to subsidize parking. Commuter associations have worked for years to change the law to eliminate the tax advantages of driving alone over the use of public transportation (*17*). In California, while employer subsidies for mass transit, carpooling, and vanpooling are exempted from income taxation, subsidies for walking or bicycling continue to be taxed as ordinary income.

Labor Legislation

Federal and state labor legislation specifying the conditions for which overtime must be paid may prevent employers from using compressed workweek schedules more extensively. Essentially, these overtime rules preclude employees from accumulating overtime hours that they may use at some future date as compensatory time. Although most administrative, executive, and managerial personnel are exempted from these government statutes, federal legislation (such as The Walsh-Healy Act, The Contract Work Hours and Safety Standards Act, and The Fair Labor Standards Act) requires payment of overtime to hourly employees who work more than 8 hr per day or 40 hr per week (*18,19*). California has one of the strictest laws regulating working hours and overtime pay. In California, however, hourly employees who work more than 8 hr per day are allowed to accumulate overtime hours, provided the employer has formally adopted a 4-day workweek schedule (*18*). Other things being equal, adoption of a 4-day workweek schedule, in which the employee works 40 hr in 4 days, would reduce the number of work trips by 20 percent.

Transportation Programs

The provision of urban transportation services is a government responsibility. Federal, state, and local governments control much of the resources to finance the supply of local transportation alternatives. The long-standing federal policy to use Interstate highway program funds almost exclusively to finance highway construction and maintenance has favored the use of automobile commuting over less polluting and congesting transportation possibilities, such as commuter rail and buses. The 1991 Intermodal Surface Transportation Efficiency Act has modified such a practice by authorizing the use of federal highway funds to finance transit capital projects, carpool projects, pedestrian walkways, and other transportation control measures identified in the Federal Clean Air Act (*20*). Shifting the policy focus from road building to transportation demand management could indirectly enhance the effectiveness of employer trip-reduction programs by increasing the supply of local transit services and stimulating carpooling, walking, and bicycling as means of traveling to work.

State transportation resources allocated to the development of high-occupancy vehicle (HOV) lanes have been shown to enhance the performance of trip-reduction programs indirectly by stimulating carpooling. For example, the establishment of HOV lanes in Orange County, California (*21*), and Minneapolis, Minnesota (*7*), has led to higher carpool formation. Savings in commuting time made possible by traveling in the HOV lane may entice employees to carpool more often (*13*).

Land Use Regulations

Land use decisions by local governments can also affect mode choice and travel behavior in different ways. First, the type and intensity of land use specified in the city's general plan may indirectly influence the quantity and type of transportation alternatives available to commuters. City areas zoned for low residential or employment density become automobile dependent because they cannot be efficiently served by traditional means of public transportation, such as mass transit. Second, the segregation of land uses by district contributes to the spatial mismatch between the location of housing and employment (*22*). Communities with sharp job-housing im-

balances encourage solo driving by creating excessive travel and long commutes. Separation of land use activities also fosters additional employee travel during the day for personal or business reasons. Finally, but not less important, the liberal parking specifications of some local jurisdictions make it more difficult for trip-reduction programs to succeed. The policy of many cities to underprice parking space in public lands, primarily on streets, encourages the use of single-occupancy vehicles (SOVs) and undermines public and private efforts to stimulate transit use or carpooling.

Federal and State Gasoline Taxes

Other public policies, such as federal and state gasoline taxes, can influence employee modal choice and the effectiveness of trip-reduction programs by affecting the cost of commuting. Economists have generally supported increases in gasoline taxes to discourage the use of SOVs. This relationship was indirectly tested during the 1970s, when higher gasoline prices caused by the higher petroleum prices charged by the Organization of Petroleum Exporting Countries led automobile commuters to switch to carpooling and public transportation. Today, however, lower gasoline prices are making carpooling less attractive. In 1991, for example, gasoline prices in the United States were about 12 percent lower than in 1981 (*23*). Further, compared with the United Kingdom, France, Japan, and Italy, gasoline prices in the United States are three to four times lower (*24*). Thus, depending on specific tax rates levied, federal and state gasoline taxes could reinforce or undermine the goal of employer-sponsored trip-reduction programs.

Education

This variable is included in the framework more for its potential than for its actual effect on the success of trip-reduction programs. Education is an invaluable tool to convey the importance and necessity of trip reduction to employees and to the public in general. Commuters know little about the social cost of the journey to work. Although most everyone is aware of the visible effects of smog, few understand and recognize the long-term harmful, and sometimes deadly, effects of air pollution (*25*). Consumer education can go a long way to raise public awareness of the subtle effects of air pollution and the necessity to improve air quality. Unfortunately, although there is a wealth of technical data linking air pollution with human health, there has not been a comprehensive public education effort to communicate this knowledge to the community. Elementary and high schools, as well as colleges and universities, could become the focal point to educate youngsters and their families on the health risks of air pollution and on the benefits to be attained by changing commuting behavior.

Employer Factors

Factors included in this component can have a major influence on the performance of the trip-reduction plan. Whereas program resources, management commitment, and program options are within the employer's control if not precluded in regulations, labor-management agreements, work site location, and employer size are not.

Program Resources

Program resources are the labor, capital, and monetary rewards that the employer devotes to implement the trip-reduction plan. Company revenues diverted to plan implementation depend on the time spent by the employee transportation coordinator (ETC) to prepare, promote, and monitor the program; the office space occupied by the ETC; the passenger vans or minibuses purchased or leased by the employer to transport employees; and the financial outlays to promote ridesharing and subsidize alternatives to solo driving. Resources allocated to the program are more limited for some employers than for others, and they may vary with the number of employees and the types of incentives offered.

Data collected by UMTA (now FTA) (*6*) on suburban employers indicate that small-scale efforts to reduce work trips might cost from $10,000 to $20,000 per year for employers with fewer than 500 employees and from $30,000 to $60,000 for employers with more than 1,000 employees. On the other hand, the cost of comprehensive ridesharing programs might vary from $30,000 to $60,000 per year for employers with fewer than 500 employees and from $100,000 to $250,000 for employers with more than 1,000 employees. Costs are generally higher for large companies because their programs usually include vanpool and shuttle services.

A recent study based on a sample of 39 trip-reduction plans filed with SCAQMD shows that the average yearly cost of developing and implementing a trip-reduction plan is about $29,000, or $70 per employee (*26*). For employers of different sizes, the cost varies as follows:

Employer Size	*Total Cost*	*Cost Per Employee*
100–199	$13,400	$70
200–500	$28,100	$86
500 +	$34,300	$50

More recently, and based on a larger sample of 1,100 trip-reduction plans submitted to SCAQMD, the annual average cost of program implementation in SCAB was estimated at $105 per employee (*27*). Nonetheless, a validity study of 17 cases, conducted shortly thereafter, revealed that 10 of these companies had overstated their program costs, some by as much as 380 percent (*28*).

The studies by Commuter Transportation Services and Ernst & Young found no connection between resources devoted to the program and its performance, as measured by the AVR attained by the employer. This is an important finding, suggesting that although some employers may spend relatively more on plan implementation, higher expenditures do not guarantee program success.

Management Commitment

A key element in the performance of employer-sponsored trip-reduction plans is management interest (*3*) or commitment to the program. Experience suggests that support from

top company officials is critical in developing and sustaining an effective ridesharing program. On the other hand, if management is not fully supportive of the program, is unsure of its value, or is skeptical of government regulation, program outcomes may fall short of the goal. At present there are no criteria to distinguish employers who are fully committed to the program from those who, in evaluation research terms, "ritually comply" (*29*) or try to conform with all the legal provisions of the regulation but make little effort to reach the stated goal. Cases of ritual compliance are also difficult to identify because most trip-reduction regulations do not have mandatory performance standards and employers only need to show a "good faith effort" to accomplish the policy-prescribed goal. The anticipated effects of the trip-reduction program can also be influenced by the person primarily responsible for its implementation. Incentives that could be effective in the hands of an experienced and highly motivated ETC may not be as effective when implemented by a less experienced or less motivated ETC.

Program Options

In general, employers rely on incentives and disincentives to discourage automobile commuting. Incentives usually include various kinds of compressed workweek schedules, telecommuting or working at home, financial and nonfinancial rewards for ridesharing, employer-sponsored carpool and vanpool programs, guaranteed ride home programs, and preferential parking for carpoolers. The influence of some of these incentives on AVR has been confirmed by two recent studies. On the basis of an analysis of 1,100 trip-reduction programs, Giuliano et al. (*8*) found that AVR increases are associated with the presence of various types of financial incentives for carpooling, riding transit, walking, and bicycling; provision of guaranteed rides home; orientation of new employees; and recognition of ridesharers in the company newsletter. This research, however, did not rank these incentives in order of importance. The other study, which relies on data from 5,593 trip-reduction programs, revealed that although carpool and transit subsidies affect AVR and changes in AVR in the expected direction, the explanatory power of these variables is low (*30*).

A well-known disincentive that employers could use to affect commuting behavior and program effectiveness is to charge employees for parking. Employee-paid parking increases the cost of automobile commuting, forcing the employee to use more economical travel alternatives. Various case studies have consistently shown that the number of automobiles driven to work is significantly reduced when employers stop subsidizing employee parking (*31,32*). Lower parking fees among employers subject to Regulation XV have been found to correlate with lower AVRs (*30,33*).

Despite all the accumulated evidence on the negative effect of employer-paid parking on modal choice, private and public sector firms continue to subsidize parking. In Southern California, 93 percent of all commuters do not have to pay for parking (*34*). In SCAB, as many as 92 percent of employers subject to Regulation XV still provide free parking to their employees (*33*). In addition to the detrimental effects on carpooling and transit use, employer-paid parking requires large expenditures by employers. According to a study conducted in 1987, employers in Los Angeles County spent between $1.3 and $1.7 billion to subsidize parking (*35*). In Southern California, parking expenditures per firm could range from $26,000 to $377,000, and the average annual subsidy per parking space could vary from $50 per space in the San Bernardino and Riverside county areas to $389 in downtown Los Angeles (*36*). If adjusted for inflation, the current value of these numbers would be much higher.

Employers also face the task of marketing the program options and fine-tuning the incentives to get employees to change their commuting habits. This process may take longer for some employers than for others. Altering employees' commuting behavior requires time to experiment with various types of incentives and overcome employees' resistance to abandon their cars. After all, the automobile has been dominant for more than 50 years, and this dominance is not likely to change overnight. In addition, employers also confront obstacles over which they have little or no control. Examples include travel patterns associated with some employee occupations (e.g., social workers and auditors) and locational constraints (e.g., poor access to public transportation). These factors also limit the types of incentives that employers can offer in their trip-reduction plan.

Labor-Management Agreements

Employers may not be able to use certain trip-reduction strategies because they may violate labor-management agreements. For example, substitution of parking benefits for a transportation allowance may not be possible without first renegotiating the labor-management contract. Another trip-reduction strategy that may require labor management negotiations is compressed workweek schedules. Some labor organizations, for example, have been known to oppose compressed workweek schedules on the grounds that a longer workweek may cause loss of overtime pay, as well as employee fatigue, which may eventually result in health and safety problems. Other unions have been supportive of compressed workweek schedules because of the potential benefits (e.g., improvement of employee morale, decrease in absenteeism, and reduction of employee turnover) that these programs may generate (*18*).

Work Site Location

Specific features associated with the location of the work site may enhance or hinder the effectiveness of the trip-reduction program. They include employment clustering and proximity to public transit.

Multiemployer centers, or the concentration of small employers, are less likely to encourage ridesharing than single-employer centers (*6,15*). It is suggested that rideshare participation is lower at multiemployer centers because the organization of a ridesharing program among various smaller companies is more difficult and requires greater coordination than at a single company (*13*).

Proximity to public transit is another locational factor that may affect the success of employer trip-reduction programs.

Considerable evidence exists to support the notion that accessibility to public transit networks reduces the use of SOVs. Employees working in places located in or near downtown areas of large cities rely on public transportation more than employees working for companies located in suburban communities, where public transportation is practically nonexistent and parking is usually free (*6,13,37*).

Employer Size

Studies indicate that ridesharers are more likely to work for large employers (*15,38,39*). Trip-reduction programs are more successful at larger employers with a smaller proportion of professional occupations (*40*). This association is traced to the greater availability of potential ridesharers found in a larger labor pool (*13*).

Employee Attributes

Employee attributes that may affect mode choice, and ultimately the performance of trip-reduction programs, include personal values, occupation, commuting distance, and household characteristics.

Personal Values

Personal values are largely shaped by sociopsychological influences (such as culture, social class, family and group influence, personality, etc.) acquired through learning and experience. In general, and depending on how strong these personal values are, the employee may have a higher or lower disposition to change his commuting behavior. For example, altruistic feelings (e.g., a desire to improve air quality) and attraction to other carpool members have been found to correlate positively with carpooling (*15*).

Hwang and Giuliano (*13*) found that although the attraction factor is positively correlated with carpooling, freedom to drive alone and the perceived negative status associated with being a driver or a passenger in a carpool may prevent people from ridesharing. Overcoming employee resistance to ridesharing arising from personal values is one of the biggest challenges that employers and public decision makers still have to face. However, the connection between personal values and travel mode is not altogether clear and is difficult to ascertain empirically (*12,41*).

Employee Occupation

Because of the special needs associated with certain occupations, ridesharing could be more difficult for some employees. The need to make daily visits to clients or customers located in different parts of the city reduces the employee's chance to rideshare or use public transportation. Irregular work schedules and part-time employment also make rideshare matching particularly difficult. Management and professional occupations appear to have lower carpool propensity than blue collar occupations (*15*). The relationship between occupation and ridesharing is sometimes attributed to the higher rate of automobile ownership and lower susceptibility to commuting costs found among professional employees (*13*).

Commuting Distance

Reviews of several studies indicate that ridesharers are more likely to have longer home-to-work trips than solo drivers (*13,15,38*). It is not clear, however, what specific factors induce individuals with longer commuting trips to join carpool programs at a higher rate. Apparently, the cost savings of sharing the ride in a long commute outweigh the inconveniences of carpooling (e.g., time spent to pick up and drop off carpool passengers) (*13*).

Household Characteristics

Household income has long been used in transportation demand models to predict modal split, primarily the commuter's choice between travel by automobile and public transit. Nevertheless, there is insufficient evidence to provide an understanding of how household income may affect the choice among alternative commuting modes other than SOVs. It is possible that household income, occupation, and work schedules interact in subtle ways to influence the employee's modal choice and propensity to use different transportation alternatives. Other household characteristics, such as family size, may also affect employees' commuting behavior. The presence of small children in the household may create child care responsibilities requiring different travel patterns.

Travel Mode Characteristics

Employees, and commuters in general, are fairly rational in deciding which particular travel mode to use. They generally perceive each travel mode as having different characteristics and distinctive benefits and costs. Travel mode characteristics usually identified in the transportation literature are cost, travel time, convenience, comfort, privacy, and safety (*12*). The trip-reduction plan, especially the program options, becomes the tool to modify the benefits and costs associated with each commuting mode.

Excluded from the employee selection of a travel mode are the social costs (e.g., the costs of accidents, traffic congestion, environmental damage, and health effects) of the various commuting travel alternatives. Thus, although ridesharing reduces the cost of commuting through fuel savings and wear and tear on automobiles, the exclusion of social costs continues to make the use of SOVs the preferred alternative for the majority of travelers. Employers, however, could partially eliminate the apparent advantage of SOVs over carpooling or the use of public transit if they were to give some serious thought to the option of charging for parking. California has enacted legislation requiring employers who subsidize parking to provide employees with the option of receiving a parking subsidy or an equivalent cash allowance. The rationale behind this legislation is that employees who do not value employer-paid parking very highly will choose the cash allowance and

stop driving their cars to work (*31*). Employers could also outweigh most advantages attributed to SOVs if they were to pay more attention to the home-based telecommuting option and use it more extensively, but, according to the *Los Angeles Times* (*42*), employers remain skeptical of this idea.

Employee Mode Choice

Employee mode choice is the first manifestation of the impact of the trip-reduction program. As presented in the framework, the employee's choice of a particular mode is a function of the combined effects of the various framework components already discussed. Conventional transportation alternatives identified in this component are automobile (or light duty truck), transit, carpooling, vanpooling, and walking. The two unconventional or less traditional alternatives listed are telecommuting and vehicles powered by methanol, natural gas, or electricity.

Outcomes or Impacts

To date, most studies of employer trip-reduction programs have used modal shares (e.g., proportion of employees who carpool) (*6,7*) and AVR (*8*) to gauge program success. These indicators, however, do not reflect accurately the emission reduction and transportation benefits expected from these programs.

The selection of performance measures, or outcome indicators, of trip-reduction programs should be dictated by the program objectives. Programmatic efforts aimed at reducing air pollution call for quantifying emission reduction benefits. Vehicle emissions are a function of vehicle type and year. Older vehicles, for example, pollute significantly more than newer ones. In general, larger engines also emit more air pollution than smaller ones.

In addition, vehicles release different levels of air pollution during three phases of vehicle operation: the cold start phase, the running phase, and the evaporative phase. Cold start emissions are generated when the vehicle engine and catalytic converter are operating cold. Running exhaust emissions occur after the vehicle engine is warmed up and depend on vehicle speed and the number of miles driven. Evaporative emissions are released when the vehicle engine is turned off and the gasoline remaining in the carburetor evaporates. Cold start and evaporative emissions are not affected by distance traveled, but running emissions are.

Thus, reliable estimates of emission reduction benefits brought about by changes in AVR or travel mode would normally require information on the number of cold starts and VMT before and after implementation of the trip-reduction program. Two employers with the same number of work trips could have quite different impacts on mobile source emissions depending on the number of trips made during the regular work day and VMT. Further, in quantifying the emission benefits of specific trip-reduction options, such as telecommuting or the 4-day compressed workweek, it would be important to know whether the commuting vehicle that remains at home is used to make other trips.

If increasing mobility is the program goal, the number of trips reduced, VMT, or level of service (LOS) during morning and evening rush hours may be used as performance indicators. The LOS concept is favored by traffic engineers, and it reflects five different levels of traffic conditions ranging from Level A (free flow) to Level F (gridlock). Using LOS to assess the traffic impacts of trip-reduction programs would be a complex undertaking because it would require measuring traffic volume, speed, and travel time.

CONCLUSIONS AND IMPLICATIONS

This paper has suggested a conceptual framework to study the effectiveness of employer trip-reduction programs. The model illustrates the complexity of the environment in which employer trip-reduction programs operate and the rather large number of variables that may impinge on program performance. The description is, at best, a tentative one. Although other variables could be added, the ones included in the framework deserve priority.

The Framework Components

From a programmatic standpoint, the effect of program resources, management commitment, and program options are most relevant. The absence of any relationship between resources allocated to the trip-reduction program and AVR attained indicates that larger expenditures by employers may not necessarily translate into program success, and lesser expenditures sometimes may be more effective in achieving the objectives of the trip-reduction plan. Although experience indicates that management commitment can make a difference in terms of program success, the specific actions, or behavior, that underlie such a concept remain largely unknown and may be ascertained only by placing greater emphasis on the "nuts and bolts" of the system or the evaluation of program effort. One way to ensure greater management commitment is to introduce mandatory performance standards in the trip-reduction regulation, along with penalties for failing to meet the policy-prescribed goal. This option, however, is likely to generate strong political opposition.

Regarding the impact of specific program options, financial incentives and parking charges keep reappearing in the literature as promising options to change commuting behavior. The analysis conducted to date, however, has yet to provide any definite clues regarding which particular incentives and disincentives are likely to produce the largest effect on program outcome. This has been partly attributed to data limitations, especially inadequate measures and lack of information on control variables (*8,30*). Depending on its proximity to public transportation, work site location has been shown to affect program performance as well.

Although remaining largely beyond the employer's influence, making employee attributes part of a comprehensive evaluation may help decision makers establish a more direct and explicit link between these antecedent variables (e.g., personal values, occupation, commuting distance, and household characteristics such as automobile ownership) and program outcomes. Having this knowledge may lead to better

market segmentation and thus more appropriate targeting of incentives and promotional activities among company employees.

Although from an operational standpoint it may be difficult to fully integrate the public policy component into the framework, its presence may remind us that existing public policies can create favorable or unfavorable conditions to the success of employer-sponsored trip-reduction programs. Reducing the adverse effects of some of these public policies on ridesharing, or enhancing their favorable impacts, would require greater political coordination between transportation and air quality planners. A good example of the long-term payoff of this kind of activity is the new provision of the Comprehensive Energy Policy Act, which raises the transit subsidy exempt from income taxation from $21 to $60 per employee, a threefold increase. It took years of organized political action to make federal income taxation policy less biased toward ridesharing.

To evaluate program impacts more conclusively, the performance or outcome indicators should reflect more accurately the emission or traffic reduction benefits expected from these programs. Nevertheless, given the complexity of the environment in which employer trip-reduction programs are carried out and the enormous challenge of changing commuter behavior, it would be unrealistic to hope for significant results during the first few years of program implementation (*43*). As pointed out in the evaluation research literature, the more complicated and intricate the environment in which public programs operate, the longer the time span required to observe program impacts (*29*).

Information Requirements

Making the framework explicit calls for the development of an information system to improve the evaluation of trip-reduction programs and their effectiveness. An adequate system should be designed for local use, and it should serve the needs of employers and public decision makers.

In the first place, it should provide specific information to facilitate assessment and testing of the impact of program and antecedent variables on outcomes. A data collection form or questionnaire could be used to gather most of the information from employers. Employer data should include detailed program costs and company size. Rating schemes could be developed to assess management commitment and ETC attitude toward the trip-reduction program. Equally important would be to assess the experience of the ETC and the time devoted to implement the program.

The types of incentives and disincentives, their costs, and the number of employees affected would be critical to the information system. Also included should be the work site location and its accessibility to public transportation. Employers could provide information on employee attributes, such as occupation, commuting distance, travel behavior, and household characteristics. It would also be helpful to obtain some indication of employee satisfaction with the type and variety of incentives offered and with the way management is implementing the trip-reduction program. In addition, the system should include more valid measures of air quality and transportation impacts.

To maintain its usefulness and preserve its policy relevance, such an information system must have certain properties. First, it must have some safeguards to control the quality of the data and ensure their integrity. Second, it must be flexible. Information collected, for example, should be periodically revised in order to discard useless or irrelevant data. Finally, it must have some stability (i.e., key definitions used in the system should not be changed too often because longitudinal analysis would not be possible).

Developing this type of information system may not be as costly as the data requirements may suggest. Many localities and air pollution control districts requiring the implementation of employer trip-reduction programs already collect a significant amount of information for administrative purposes. In addition, data collection costs could be substantially reduced by using carefully selected samples of employers and employees. Thus, to the extent that the new information collected would be supplementing an existent system, the additional cost of data gathering would probably not be high. The benefits, however, would be the creation of a more reliable data base to assess and improve program effectiveness.

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