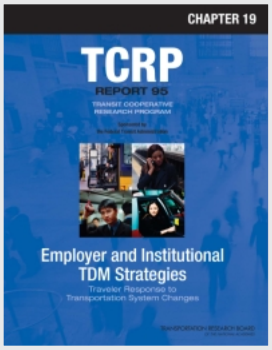

Traveler Response to Transportation System Changes Handbook, Third Edition: Chapter 19, Employer and Institutional TDM Strategies

DETAILS

173 pages | | PAPERBACK
ISBN 978-0-309-11836-1 | DOI 10.17226/14393

AUTHORS

Richard H Pratt; J Richard Kuzmyak; John E Evans; Transportation Research Board

TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP REPORT 95

Traveler Response to Transportation System Changes

Chapter 19—Employer and Institutional TDM Strategies

J. RICHARD KUZMYAK
Lead Chapter Author

JOHN E. (JAY) EVANS, IV
AND
RICHARD H. PRATT
Contributing Chapter Authors

RICHARD H. PRATT, CONSULTANT, INC.
Garrett Park, MD
JAY EVANS CONSULTING LLC
Washington, DC
TEXAS TRANSPORTATION INSTITUTE
College Station, TX
PB AMERICAS, INC.
Baltimore, MD, Portland, OR, and San Francisco, CA
J. RICHARD KUZMYAK, L.L.C.
Silver Spring, MD
CAMBRIDGE SYSTEMATICS, INC.
Bethesda, MD
VANASSE HANGEN BRUSTLIN, INC. / VHB
Vienna, VA
GALLOP CORPORATION
Rockville, MD
MCCOLLOM MANAGEMENT CONSULTING, INC.
Darnestown, MD
HERBERT S. LEVINSON, TRANSPORTATION CONSULTANT
Wallingford, CT
K.T. ANALYTICS, INC.
Bethesda, MD

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The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), Transportation 2000, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academies, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

TCRP REPORT 95: Chapter 19

Project B-12A
ISSN 1073-4872
ISBN 978-0-309-11836-1
Library of Congress Control Number 2003108813

Published reports of the

TRANSIT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at

http://www.national-academies.org/trb/bookstore

Printed in the United States of America

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FOREWORD

By Stephan A. Parker
Staff Officer
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TDM (transportation demand management or travel demand management) is a process that can encompass a variety of measures intended to influence travel choices. TDM is used to manage heavy traffic demand and parking requirements, and to enhance the effectiveness of transit services. Employer and institutional TDM actions within the scope of this chapter can be classified into four major categories: employer or institutional support actions, provision of transportation "services," financial incentives or disincentives, and alternative work arrangements.

In this report, new as well as synthesized research is presented. Using a collection of 82 cases as an analysis platform, the authors evaluate the relative importance of particular categories of TDM strategies (e.g., support versus incentives), and even, to some degree, of particular strategies (e.g., a transit subsidy versus an HOV parking discount), through pair-wise comparisons from the sample.

TCRP Report 95: Chapter 19, Employer and Institutional TDM Strategies will be of interest to transit, transportation, and land use planning practitioners; land developers, business associations, employers, institutions, and employees; educators and researchers; and professionals across a broad spectrum of transportation and planning agencies, MPOs, and local, state, and federal government agencies.

The overarching objective of the *Traveler Response to Transportation System Changes Handbook* is to equip members of the transportation profession with a comprehensive, readily accessible, interpretive documentation of results and experience obtained across the United States and elsewhere from (1) different types of transportation system changes and policy actions and (2) alternative land use and site development design approaches. While the focus is on contemporary observations and assessments of traveler responses as expressed in travel demand changes, the presentation is seasoned with earlier experiences and findings to identify trends or stability, and to fill information gaps that would otherwise exist. Comprehensive referencing of additional reference materials is provided to facilitate and encourage in-depth exploration of topics of interest. Travel demand and related impacts are expressed using such measures as usage of transportation facilities and services, before-and-after market shares and percentage changes, and elasticity.

The findings in the *Handbook* are intended to aid—as a general guide—in preliminary screening activities and quick turn-around assessments. The *Handbook* is not intended for use as a substitute for regional or project-specific travel demand evaluations and model applications, or other independent surveys and analyses.

The Second Edition of the handbook *Traveler Response to Transportation System Changes* was published by USDOT in July 1981, and it has been a valuable tool for transportation professionals, providing documentation of results from different types of transportation actions. This Third Edition of the *Handbook* covers 18 topic areas, including essentially all of the nine topic areas in the 1981 edition, modified slightly in scope, plus nine new topic areas. Each topic is published as a chapter of TCRP Report 95. To access the chapters, see the project write-up on the TCRP website: http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=1034.

A team led by Richard H. Pratt, Consultant, Inc. is responsible for the *Traveler Response to Transportation System Changes Handbook, Third Edition,* through work conducted under TCRP Projects B-12, B-12A, and B-12B.

REPORT ORGANIZATION

The *Handbook*, organized for simultaneous print and electronic chapter-by-chapter publication, treats each chapter essentially as a stand-alone document. Each chapter includes text and self-contained references and sources on that topic. For example, the references cited in the text of Chapter 6, "Demand Responsive/ADA," refer to the Reference List at the end of that chapter. The *Handbook* user should, however, be conversant with the background and guidance provided in *TCRP Report 95: Chapter 1, Introduction.*

Upon completion of the *Report 95* series, the final Chapter 1 publication will include a CD-ROM of all 19 chapters. The complete outline of chapters is provided below.

Handbook Outline Showing Publication and Source-Data-Cutoff Dates

General Sections and Topic Area Chapters (TCRP Report 95 Nomenclature)	U.S. DOT Publication: First Edition	U.S. DOT Publication: Second Edition	TCRP Report 95: Source Data Cutoff Date	TCRP Report 95: Publication Date
Ch. 1 – Introduction (with Appendices A, B)	1977	1981	2003 a	2000/03/12[a]
Multimodal/Intermodal Facilities				
Ch. 2 – HOV Facilities	1977	1981	1999-05[b]	2006
Ch. 3 – Park-and-Ride/Pool	—	1981	2003[c]	2004
Transit Facilities and Services				
Ch. 4 – Busways, BRT and Express Bus	1977[e]	1981	—[d]	—[d]
Ch. 5 – Vanpools and Buspools	1977	1981	1999-04[b]	2005
Ch. 6 – Demand Responsive/ADA	—	—	1999	2004
Ch. 7 – Light Rail Transit	—	—	—[d]	—[d]
Ch. 8 – Commuter Rail	—	—	—[d]	—[d]
Public Transit Operations				
Ch. 9 – Transit Scheduling and Frequency	1977	1981	1999	2004
Ch. 10 – Bus Routing and Coverage	1977	1981	1999	2004
Ch. 11 – Transit Information and Promotion	1977	1981	2002	2003
Transportation Pricing				
Ch. 12 – Transit Pricing and Fares	1977	1981	2002	2003
Ch. 13 – Parking Pricing and Fees	1977[e]	—	1999	2005
Ch. 14 – Road Value Pricing	1977[e]	—	2002-03[b]	2003
Land Use and Non-Motorized Travel				
Ch. 15 – Land Use and Site Design	—	—	2001-02[b]	2003
Ch. 16 – Pedestrian and Bicycle Facilities	—	—	2007-10[b]	2011[d]
Ch. 17 – Transit Oriented Development	—	—	2004-06[b]	2007
Transportation Demand Management				
Ch. 18 – Parking Management and Supply	—	—	2000-02[b]	2003
Ch. 19 – Employer and Institutional TDM Strategies	1977[e]	1981[e]	2007-09[b]	2010

NOTES: [a] Published in TCRP Web Document 12, *Interim Handbook* (March 2000), without Appendix B. The "Interim Introduction," published as Research Results Digest 61 (September 2003), is a replacement, available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rrd_61.pdf. Publication of the final version of Chapter 1, "Introduction," as part of the TCRP Report 95 series, is anticipated for 2012.
[b] Primary cutoff was first year listed, but with selected information up into second year listed.
[c] The source data cutoff date for certain components of this chapter was 1999.
[d] Deferred for a future TCRP project effort.
[e] The edition in question addressed only certain aspects of later edition topical coverage.

CHAPTER 19 AUTHOR AND CONTRIBUTOR ACKNOWLEDGMENTS

TCRP Report 95, in essence the Third Edition of the "Traveler Response to Transportation System Changes" Handbook, is being prepared under Transit Cooperative Research Program Project B-12 as amended by Richard H. Pratt, Consultant, Inc., in association with Jay Evans Consulting LLC; the Texas Transportation Institute; PB Americas, Inc.; J. Richard Kuzmyak, L.L.C.; Cambridge Systematics, Inc.; Vanasse Hangen Brustlin, Inc./VHB; Gallop Corporation; McCollom Management Consulting, Inc.; Herbert S. Levinson, Transportation Consultant; and K.T. Analytics, Inc.

Richard H. Pratt is the Principal Investigator. Dr. Katherine F. Turnbull of the Texas Transportation Institute assisted as co-Principal Investigator during initial Project B-12 phases, leading up to the Phase I Interim Report and the Phase II Draft Interim Handbook. With the addition of Project B-12B research, John E. (Jay) Evans, IV, then of Jay Evans Consulting LLC, was appointed co-Principal Investigator. Lead Handbook chapter authors and co-authors, in addition to Mr. Pratt, are Mr. Evans (initially with Parsons Brinckerhoff and now with Cambridge Systematics); Dr. Turnbull; J. Richard Kuzmyak, initially of Cambridge Systematics and now of J. Richard Kuzmyak, L.L.C.; Frank Spielberg of VHB; Brian E. McCollom of McCollom Management Consulting, Inc.; Herbert S. Levinson, Transportation Consultant; Erin Vaca of Cambridge Systematics, Inc.; and Dr. G. Bruce Douglas of PB. Contributing authors include Dr. Kiran U. Bhatt, K.T. Analytics, Inc.; Shawn M. Turner, Texas Transportation Institute; Dr. Rachel Weinberger, Cambridge Systematics (now with the University of Pennsylvania); Andrew Stryker, PB; Dr. C. Y. Jeng, Gallop Corporation; and Daniel Nabors, VHB.

Other research agency team members contributing to the preparatory research, synthesis of information, and development of this Handbook have been Stephen Farnsworth, Laura Higgins, and Rachel Donovan of the Texas Transportation Institute; Nick Vlahos, Vicki Ruiter, and Karen Higgins of Cambridge Systematics, Inc.; Greg Benz, Bill Davidson, G.B. Arrington, and Lydia Wong of PB, along with the late travel demand modeler/planner extraordinaire Gordon W. Schultz; Kris Jagarapu of VHB; Sarah Dowling of Jay Evans Consulting LLC; and Laura C. (Peggy) Pratt of Richard H. Pratt, Consultant, Inc. Dr. C. Y. Jeng of Gallop Corporation has provided pre-publication numerical quality control review throughout. By special arrangement, Dr. Daniel B. Rathbone of The Urban Transportation Monitor searched past issues. Assistance in word processing, graphics, and other essential support has been provided by Bonnie Duke and Pam Rowe of the Texas Transportation Institute; Karen Applegate, Laura Reseigh, Stephen Bozik, and Jeff Waclawski of PB; others too numerous to name but fully appreciated; and lastly the warmly remembered late Susan Spielberg of SG Associates (now part of VHB).

Special thanks go to all involved for supporting the cooperative process adopted for topic area chapter development. Members of the TCRP Project B-12/B-12A/B-12B Project Panel, named elsewhere, are providing review and comments for what will total some 18 individual publication documents/chapters. They have gone the extra mile in providing support on call including leads, reports, documentation, advice, and direction over the almost-decade-and-a-half duration of the project. Four consecutive appointed or acting TCRP Senior Program Officers have given their support: Stephanie N. Robinson, who took the project through scope development and contract negotiation; Stephen J. Andrle, who led the work during the Project B-12 Phase and on into the TCRP B-12A Project Continuation; Harvey Berlin, who saw the Interim Handbook through to Website publication; and Stephan A. Parker, who is guiding the entire project to its ultimate fruition. Editor Natassja Linzau is providing her careful examination and fine touch, while Publications Director Eileen Delaney and her team are handling all the numerous publication details. TRB Librarian Jessica Fomalont has provided invaluable literature procurement aid. The efforts of all are greatly appreciated.

Continued recognition is due to the participants in the development of the First and Second Editions, key elements of which are retained. Co-authors to Mr. Pratt were Neil J. Pedersen and Joseph J. Mather for the First Edition, and John N. Copple for the Second Edition. Crucial support and guidance for both editions was provided by the Federal Highway Administration's Technical Representative (COTR), Louise E. Skinner.

In the *TCRP Report 95* edition, J. Richard Kuzmyak is the lead author for this volume: Chapter 19, "Employer and Institutional TDM Strategies." Contributing authors for Chapter 19 are John (Jay) Evans, IV, and Richard H. Pratt.

Participation by the profession at large has been absolutely essential to the development of the Handbook and this chapter, which has received the special attention of TRB Transportation Demand Management Committee ABE50 past chairs/chair and selected members. Past Chairs Eric Schreffler and Philip L. Winters, and Chair Lori Diggins—aided by committee members Tom Rye, Peter Valk, and members of the MassRIDES Outreach team, including Kay Carson, Jennifer Doyle, and Donna Smallwood—reviewed an early version, providing extensive comments, guidance, and information leads. Sara Hendricks, Ed Hillsman, and Judy Clark stepped in to provide additional reviews of the formal review draft. The contribution of each and all is truly valued.

Finally, sincere thanks are due to the many other practitioners and researchers who were contacted for information and unstintingly supplied both that and all manner of statistics, data compilations, and reports. Though not feasible to list here, many appear in the "References" section entries of this and other chapters.

CONTENTS

19 – Employer and Institutional TDM Strategies

OVERVIEW AND SUMMARY

Transportation Demand Management (TDM) refers to a body of actions that seek "to manage the demand for travel by drive-alone private car, rather than catering for that demand, or managing the road system . . ." (Ison and Rye, 2008). Managing the road system comes under the category of Transportation Systems Management (TSM). TDM is in the family of actions referred to as demand-side strategies (Association for Commuter Transportation et al., 2004).

TDM program goals include achieving traffic and vehicle miles of travel (VMT) reduction and all of the associated transportation, environmental, conservation, and sustainability benefits, generally without large infrastructure investments. Actions may be directed at increasing vehicle occupancy, shifting travel mode or time of travel, or reducing the need for travel. Programs can include supportive actions, special transportation services, financial incentives, or alternative work arrangements. TDM programs can also involve parking management and regular transit service enhancements; however, these topics are for the most part discussed in other chapters within this *TCRP Report 95* "Traveler Response to Transportation System Changes" Handbook (see below).

TDM can involve many stakeholders, including landowners, developers, employers and institutions, employees, business associations, and local, regional, and state levels of government. This chapter provides a synthesis on the potential for employer- or institution-based TDM strategies, in particular, to influence travel behavior.

This "Overview and Summary" section presents:

- "Objectives of TDM Strategies," highlighting the various goals and purposes of employer and institutional TDM strategies.
- "Types of TDM Strategies," categorizing and describing the predominant employer and institutional TDM program elements for purposes of chapter organization.
- "Analytical Considerations," covering methods used in quantifying response to employer and institutional TDM strategies, limitations of available research, and cautions that thus apply to its use.
- "Traveler Response Summary," providing an encapsulation of the key travel demand findings related to employer and institutional TDM strategies. It is recommended that all lead-in "Overview and Summary" subsections be read as background for both the "Traveler Response Summary" and the chapter as a whole.

Following the "Overview and Summary" are sections on:

- "Response by Type of TDM Strategy," reviewing travel demand findings related to a variety of individual TDM program elements.
- "Underlying Traveler Response Factors," providing perspective on the behavioral mechanisms at work in achieving results with employer- and institutional-based TDM.
- "Related Information and Impacts," addressing non-travel-specific implications of TDM strategy implementation such as air quality impacts.
- "Case Studies," presenting five examples of employer and institutional TDM strategy applications with varying degrees of public involvement.

Because this chapter is focused on employer and institutional TDM strategies, it does not directly address public-agency-based TDM programs, most especially programs with which an employer or institution would have little direct involvement. Travel demand effects of most of such program types are covered in other chapters of this "Traveler Response" Handbook, as follows:

- High occupancy vehicle (HOV) lanes and other provisions for expediting movement of HOVs (strategies typically classed as TDM and/or TSM) are covered in Chapter 2, "HOV Facilities."
- Road value pricing, including central area congestion pricing, is the subject of Chapter 14, "Road Value Pricing," with a High Occupancy Toll (HOT) lane update within Chapter 2 under "Traveler Response by Type of HOV Application"—"Response to HOV Facility Exempt Vehicle and Value Pricing Programs."
- Operational-level transit service enhancements are addressed in Chapter 9, "Transit Scheduling and Frequency"; Chapter 10, "Bus Routing and Coverage"; and—to the extent express bus can be considered an operational-level strategy—in Chapter 4, "Busways, BRT and Express Bus."
- "Vanpools and Buspools" is the sole subject of Chapter 5.
- Transit promotion and pricing, including travel pass partnership programs, are topics of Chapter 11, "Transit Information and Promotion," and Chapter 12, "Transit Pricing and Fares."
- Parking strategies, especially important to TDM, are covered in two chapters—Chapter 13, "Parking Pricing and Fees," and Chapter 18, "Parking Management and Supply."
- Land use and non-motorized travel considerations are addressed in Chapter 15, "Land Use and Site Design"; Chapter 16, "Pedestrian and Bicycle Facilities"; and Chapter 17, "Transit Oriented Development."

Beyond what is contained within the chapters of *TCRP Report 95,* resources that cover the broader scope of TDM are identified in the "Additional Resources" section. Also, the regional effect of employer and institutional TDM strategies is felt to be of sufficient importance that a "Site- Versus System-Level Impacts" discussion is included in this chapter's "Related Information and Impacts" section, supported by a case study on overall TDM program effects.

Within the realm of employer and institutional TDM strategies, Chapter 19 is unique in the extent to which individual components—individual TDM measures—are covered in other chapters, specifically the chapters identified above. In general, where individual TDM measures are the subject of other chapters or chapter subsections, the material assigned to this "Employer and Institutional TDM Strategies" chapter is only that which pertains to how a measure relates to overall TDM programs and works in conjunction with other measures within TDM program packages. However, for most TDM measures, the more recent twenty-first century findings are presented only here in Chapter 19, which serves as a limited update for TDM-related Handbook chapters published earlier.

Objectives of TDM Strategies

TDM strategies are used as an important component in the mix of improvements and policies needed to address congestion and provide more options than driving alone. They include incentives and disincentives which are designed to encourage automobile drivers to travel in less congested times or to find an alternative mode which does not lead to the same peak-hour congestion. Among the objectives of TDM actions are: congestion mitigation, improved air quality, reduced energy consumption, reduced carbon emissions, land development support, and employee benefits.

Actions to mitigate congestion may include as objectives increasing vehicle occupancy and reducing vehicle miles of travel. Such actions tend to have benefits in reducing emissions and energy usage. Actions oriented to spreading peak-period travel may target overcrowding of both transit and highway facilities.

Some TDM strategies are used with the objective of supporting more development or density than might otherwise be possible because of either regulations or physical constraints. TDM actions can improve the access to or utilization of particular sites. Parking needs or requirements may also be reduced, potentially freeing up space for additional development.

Finally, some TDM actions may have as their objective to ease travel burdens for employees or customers, or to address employer worksite issues, such as benefits, recruitment, retention, productivity, or absenteeism.

Types of TDM Strategies

TDM can stand for transportation demand management or travel demand management. The terms are interchangeable. It is a process that can encompass a variety of measures intended to influence travel choices. TDM is used to manage heavy traffic demand and parking requirements, and to enhance the effectiveness of transit services. Employer and institutional TDM actions within the scope of this chapter can be classified into four major categories: employer or institutional support actions, provision of transportation "services," financial incentives or disincentives, and alternative work arrangements. Each is described in more detail in the subsections that follow.

Employer or Institutional Support Actions

This broad category of actions includes measures taken by employers or institutions to support the use of alternatives to single occupancy vehicles during peak hours by employees and others. These measures, which serve to raise awareness, provide information, remove impediments, and encourage use of travel alternatives, generally do not involve any financial inducement or physical service offerings. Examples include: transportation coordinators; on-site transit information and/or pass sales; rideshare matching services; preferential parking for carpools or vanpools; provision of bike lockers, showers, and/or changing facilities; and guaranteed ride home.

Many TDM employers also offer flexible work hours, in order to allow employees to accommodate transit or ridesharing scheduling constraints. While this is an important support action, it is discussed in more detail later in conjunction with alternative work arrangements. Employers in a large employment center may also belong to a transportation management association (TMA), which avails them and their employees of a wider array of travel opportunities and incentives. Support actions include:

Transportation Coordinators. Transportation coordinators are professionals located at a transportation management association or at an employment site who provide personalized trip planning and assistance to commuters. The presence of an on-site coordinator can make it easier to obtain information about alternatives to single occupancy vehicle commutes.

Transportation Management Association (TMA). TMAs are an association of public and private entities concerned with traffic congestion and transportation issues in a specific geographic area. TMAs allow businesses to pool their resources in executing commuter support strategies. The TMA may also act in an advocacy role with local government on behalf of its membership.

On-Site Transit Information and Pass Sales. Providing transit information on-site can lower the barriers that may prevent people from trying transit. Convenient purchase of transit passes may also facilitate trying out transit use. In addition, on-site sales may support introduction of site-specific transit pass discounts.

Rideshare Matching Services. Rideshare matching services put compatible commuters in touch with one another to enable carpooling. Employers can facilitate formation of ridesharing arrangements by employees in a number of ways, ranging from simple in-house employee match listings to computerized matching programs. These services may be unique to the given employer or can pool matching candidates from a larger area ranging from multiple employers in a building or complex to large regional matching systems.

Guaranteed Ride Home. Guaranteed ride home programs provide backup transportation to employees who rideshare or use transit if they need to return home suddenly for an emergency, or if they must work late and therefore cannot connect with the mode they used to travel to the site on that day. Generally, these programs provide vouchers for the person to travel home by taxi, although some employers permit use of company vehicles as well. Guaranteed ride home may be provided by the individual employer or through a broader local or regional program. While a guaranteed ride home may be seldom used, it is felt to be important in reducing reliance on a personal vehicle at the workplace and thus lessening the need to drive alone.

Preferential Parking. Employers may set aside reserved parking spaces as an incentive to carpool or vanpool. This is a non-monetary benefit that can be an important incentive if parking is tight, or if the parking lot is large and the reserved spaces are near the building entrance. Reserved spaces may also be sheltered versus outdoors, lessening the impact of severe weather.

Bicycle Storage, Lockers, and Changing Facilities. Changing facilities and showers and secure bicycle parking are key features for an employer or institution interested in encouraging bicycle use. Such facilities may be combined with an exercise facility and may encourage healthy habits. Some employers provide a transportation allowance that may be used by bicycle commuters. Chapter 16, “Pedestrian and Bicycle Facilities,” discusses these in more detail, but this chapter discusses employer and institutional support for bicycles in the context of TDM programs.

Provision of Transportation Services

A small number of employers choose to become directly involved in providing attractive transportation alternatives to their employees. They do this either by contracting for special services, operating their own services, or taking a lead role in the purchasing, leasing, or maintenance of transportation vehicles. Most often this occurs because the work site is poorly located in relation to public transit access. On other occasions, the employer feels a need or desire to become active in employee transportation, or has a preference for a particular type of mode or service.

Shuttle Bus Services. Some employers choose to operate shuttle bus services to provide easy connections with nearby rapid transit services or other important facilities. Shuttle services may be an individual employer effort or a collective effort of a few sites. In some instances, shuttles are also used for local circulation during the midday, lessening the need to bring a personal vehicle to the job site.

Contract Transit Service. In some cases, employers will contract with a private bus operator or with a public transit agency to either operate special transit routes or to supplement service to their particular site. Urban hospitals or medical centers with limited parking for staff and visitors frequently make arrangements for additional bus service, often through financial assurances that a given level of ridership will occur.

Vanpool Formation Assistance/Cost Sharing. Since a vanpool carries between 7 and 12 passengers, large employers may find that vanpools provide an effective commute alternative for their employees, particularly when a large percentage live a substantial distance from the site and when transit service to the site is limited. Employers can support vanpooling through a variety of ways, from purchase or leasing of vehicles, to underwriting insurance or maintenance costs, or even providing and maintaining the vehicles themselves. Fare subsidies are a particular type of vanpool assistance measure, and these are discussed under "Financial Incentives or Disincentives" below. While this chapter discusses the role of vanpools in travel demand management programs, Chapter 5, "Vanpools and Buspools," provides detailed information on vanpools as a travel alternative.

Use of Company Vehicles. Employers who maintain fleet vehicles (which may include employee vanpools) will sometimes offer those vehicles for midday business travel, and sometimes for personal errands or emergencies. Some employers allow use of company vehicles for commuting by a registered carpool. (The phrase "company vehicles" is often used within this chapter as shorthand for these types of activities.)

Bicycle Loan Programs. While bicycling may or may not be suitable in current workplace locations as an alternative mode for commuting, making bicycles available for employees on site can help reduce the need to use a car for certain midday trips. Particularly on large suburban campuses, easy access to a bicycle can aid in trips to other functions on the site or nearby commercial/retail opportunities. Bicycles can also facilitate access to transit from the employment site.

Financial Incentives or Disincentives

Financial incentives or disincentives are actions of tangible monetary value which either *encourage* employees/commuters to make use of a particular alternative, or *discourage* them from some other course of action. These actions may have an obvious monetary value, such as a subsidy or parking fee. Alternatively, they may be of such a nature that a monetary value can be imputed, an example being the earning of points toward a tangible reward. There are many variations on how "money" can be used to influence behavior.

Transit Subsidies. Employers can reduce the cost of taking transit by offering prepaid or discounted transit passes to employees who agree to commute by transit. This benefit can vary from a modest share of the actual cost to full absorption of the cost, and instances have been observed where employees have been subsidized *more than* the actual fare being charged. Federal tax law allows employees to receive a transit subsidy of up to $230 per month without incurring tax liability for that benefit, while some states offer the employer a tax credit for paying such subsidies. Governments or transit agencies can supplement these subsidies through their own special programs that reward large customers or employers who provide substantial subsidies.

Vanpool Subsidies. Employers may subsidize the cost of vanpooling in a variety of ways. Federal tax law now extends the tax-free subsidy provision to vanpool as well as transit user fees. Employers can also offer start-up (empty seat) subsidies to support a vanpool during its formative stage (keeping the cost down for initial riders), short-term promotional fare subsidies, or driver subsidies. Vanpools can also be subsidized through a variety of indirect methods, the monetary value of which can be quantified. Employers can help procure or arrange financing for the vehicle, they can provide fuel or maintenance, and they can pay for or underwrite insurance.

In-Kind Incentives. Instead of cash, direct support for alternative transportation may be provided in other ways. Free or discounted products or services may be provided in lieu of cash. Relating the in-kind incentives to the transportation mode can provide synergism. For example, carpoolers and vanpoolers might receive gasoline or oil changes, transit riders might receive transit passes, walkers might receive shoes, and bicyclists might receive bike accessories or mechanical services.

Parking Supply and Pricing. Perhaps the biggest lever available to employers and institutions interested in reducing single occupancy vehicle use for access to their facility is the imposition of parking supply constraints or parking pricing. Because parking is itself such a powerful determinant of travel behavior, it has been given separate coverage in Chapter 13, "Parking Pricing and Fees," and Chapter 18, "Parking Management and Supply." An effort has been made not to duplicate that coverage in this chapter. The reader should be aware that many employer and institutional TDM programs include a parking component.

Alternative Work Arrangements

Alternative work arrangement actions are strategies that modify the time of travel or frequency of travel. They include flexible or staggered work hours, compressed work weeks (CWW), and telecommuting.

Flexible Work Hours. Flexible work hours are programs allowing employees a degree of freedom in choosing their starting and quitting times. Employees must be at work during core periods (typically 9:30 to 11:30 AM and 1:30 to 3:30 PM) and must observe earliest allowed starting time and latest allowed quitting time limitations. Employers may restrict how much daily flexibility workers have in scheduling their work day.

Staggered Work Hours. Staggered work hours are a fixed scheduling of work that normally spreads the employee starting and quitting times over a 1- to 3-hour period, with individual groups of employees designated to report and leave at 15 to 30 minute intervals. Staggered work hours are generally employed in large facilities, especially manufacturing, where work schedules are otherwise regular.

Compressed Work Week. CWW allows employees to work a greater-than-standard number of hours each day so as to reduce the total number of days worked, and hence, the number of times it is necessary to commute to the work site. A popular arrangement is the 9/80 schedule in which employees work 9 hours per day versus the standard 8 hours, and then get the 10th day off. Generally, employees arrange with the employer which day of the week will be their day off, typically choosing a Monday or Friday in order to extend their weekend.

Telecommuting. Telecommuting (or "Telework") is an arrangement whereby an employee is permitted to work at a remote location one or more days a week rather than commute to the work site. The availability of telecommunications technology which allows the worker to remain in "virtual" contact with the work site via a networked home or other remote computer is the basis for the naming of this strategy. However, not all employees who telecommute are necessarily working on a computer, and hence the real characteristic of the strategy is that the employee is allowed to work offsite. The offsite location is generally the home or sometimes at a remote "telework center" which has the necessary equipment. As with CWW or staggered work hours, employees who telecommute generally do so on a fixed schedule that they negotiate with their employer.

Analytical Considerations

Attempting to quantify the impact of TDM strategies on traveler behavior brings several critical analytical considerations to light.

- It is almost never the case that a given TDM strategy is implemented (or evaluated) in isolation, as a unique action. Rather, strategies are normally implemented in combinations, or "packages," such that ascertaining the effectiveness of an individual action is statistically very challenging.

- Added to the statistical challenge is the fact that the available data for conducting these analyses are seriously limited. If travel data have been collected, they are almost always for a post-implementation period and do not offer a comparative "before" measure. The data collection methods themselves are also often suspect, as is the aggregate format (total mode split or "average vehicle ridership") in which they are typically presented.

- Accounting for setting and context is very important. The effects of some strategies may be much more significant in an environment where there is good transit service, where parking is limited and priced, or where other activities are reachable from the work site without a personal vehicle.

- Finally, the details on program strategies themselves are often incomplete or inconsistent. It is often the case that neither the magnitude of incentives/services nor the time a strategy has been in place is reported. Moreover, it is usually not recorded whether individual strategies were poorly implemented or well run.

As is evident from the list in the preceding subsection, there are a large number of TDM strategies. Given the many ways in which they can be bundled and applied, attempting to present estimates of travel impact for individual strategies is simply not always possible with the data and analyses from existing research studies and databases.

Many TDM studies are both topical and qualitative, focusing on a particular type of programmatic strategy or approach, but offering little numerical information as to impacts. These studies tend to be focused more on reporting "who" has used a particular strategy or approach, "how" they implemented it, and the circumstances underlying "why" that approach was taken. In many cases, the impetus is a legal or regulatory requirement, and the issue is in assessing the reasonableness or overall effectiveness of the requirement.

It might be expected that significant TDM impact information would be available from the various state- or regionally-enacted employer trip reduction programs introduced in the late 1980s/ early 1990s, largely in response to concerns about worsening air quality in major metropolitan areas. California was the vanguard in these efforts, with passage of Regulation XV in 1987. This action legally required employers in the Los Angeles region with 100 or more employees to introduce measures to discourage driving and to reduce employee vehicle trips by 15 percent. This state initiative presaged a similar national initiative written into the 1990 Clean Air Act Amendments, requiring metropolitan areas in "severe" non-attainment of National Ambient Air Quality Standards (NAAQS) for ozone to implement similarly-structured Employee Commute Options (ECO) programs.

The California program, and many of those patterned after it (e.g., Washington State's Commute Trip Reduction Law and Portland, Oregon's Regional Transportation Options program) formalized employer participation by requiring travel surveys of employees and the development of a plan detailing the trip reduction goal, the current gap, and the specific set of TDM strategies that would be used to reach the goal. These travel data and employer TDM plans were computerized and stored in massive databases to be used for subsequent tracking of performance and evaluation of effectiveness. Employers would be evaluated on a biennial basis, necessitating a new employer survey and a revised plan with additional strategies as necessary to achieve their respective trip reduction target.

While these data archives would appear to offer great opportunity to obtain measurements of exactly the type of strategy-impact relationships which are the subject of this chapter, a number of factors cause these data to be of limited use:

- The travel survey data collected by employers were reduced to aggregate measures before data release. Five-day-week average mode shares for the employer were computed. Also computed was the Average Vehicle Ridership (AVR), an amalgam of employee commute trips by all modes and means into an effective commutes-per-vehicle rate (covered employees reporting to work divided by the vehicle round trips thus produced, per average day, over a 5-day week). To the extent that some employees telecommuted or participated in a CWW schedule, that too was embedded into the AVR for an average day.[1]

- The processed data lack any record of the characteristics of individual trips, and there is no tracking of individuals between surveys. The analyst must try to explain changes in the aggregate travel measures—between consecutive plans—with nothing more than information about the composition of the TDM program. The processed data provide no clue as to individual

[1] The inverse of the AVR is average vehicle trips per employee, one of two common vehicle trip rate expressions found in the TDM literature, though not always implying a rigorous 5-day average. The other common vehicle trip rate expression is average vehicle trips per 100 employees. Both are used within this chapter. The former is always less than one, e.g., 0.85, while the latter is nearly always a two-digit number, e.g., 85. Both are expressed in terms of complete round trips, in contrast to the usual transportation demand analysis practice of counting individual one-way trips or trip ends. Either trip rate expression (and also AVR) may be used to compute vehicle trip reduction (VTR), a dimensionless rate, so long as consistency is maintained.

worker socio-demographics, trip origins/destinations, trip length, quality of travel alternatives, or changes over time in travel alternatives available.

- There is considerable uncertainty in determining exactly what strategies (or incentives) were being applied in a given employer program, based on the information supplied in the required Trip Reduction Plans. Details were often found to be missing in terms of specific strategies, when they were invoked, to whom they were available, or what monetary value they represented. For example, it might be recorded that a transit subsidy was provided, but with no information on the dollar value of that subsidy.

- The reliability of the data, as entered into the massive databases involved, has often been found wanting. In some areas, such as in Washington State and Portland, Oregon, the massive amounts of information collected tended to overwhelm budgeted data processing capabilities, resulting in large amounts of these data waiting to be processed or purged of questionable data records.

Numerous entities have attempted to take on the challenge of analyzing these data, but with limited success (Giuliano, 1992; Comsis, 1993b; CUTR, 2004). Simply put, the precision of the data was found to be too coarse to permit use of the necessary multivariate statistical tools. Two exceptions are noted here, largely because of an important departure from the standard analytic approach:

- The first is a study sponsored by the California Air Resources Board (CARB) which, recognizing the limitations of the Regulation XV database, commissioned an original survey of 45 employers in Los Angeles and Sacramento. This enabled the researchers to control the quality of the response data on employee travel and specific strategies in operation, and to analyze travel response at an individual traveler level, rather than an aggregate outcome for the employer. Unfortunately, the research did not have access to pre-program baseline data for the surveyed employees, which seriously limited its ability to analyze behavioral changes in response to the given employer program (Comsis, 1993a). Nevertheless, the findings from this study are somewhat unique and are reported later in the "Related Information and Impacts" section.

- The second is a more recent effort by the University of South Florida's Center for Urban Transportation Research (CUTR), done under its National Center for Transit Research, which has attempted to develop a Worksite Trip Reduction Model using data from the California (Regulation XV), Washington State Commute Trip Reduction (CTR), and Tucson, Arizona, employer databases. While CUTR experienced the same types of data problems as identified by Comsis in its 1993 study for CARB, it opted to use a different statistical approach, one incorporating "neural networks," to extract relationships (CUTR, 2004). This research is also summarized in the "Related Information and Impacts" section. (The model itself has subsequently been updated, as covered in Footnotes 14 and 20 of the "Related Information and Impacts" and "Additional Resources" sections, respectively.)

The primary focus of this chapter on quantifying the link between TDM strategies and travel behavior ultimately led to a small number of studies that specifically focused on that aspect of TDM programs without attempting to rely exclusively on the large databases critiqued above. The three studies most extensively utilized are as follows:

- Comsis Corporation and Institute of Transportation Engineers, "Implementing Effective Travel Demand Management Measures: Inventory of Measures and Synthesis of Experience." Prepared for Federal Highway Administration and Federal Transit Administration, Washington, DC (1993).

- Rutherford, G. S., Badgett, S. I., Ishimaru, J. M., and MacLachlan, S., "Transportation Demand Management: Case Studies of Medium-Sized Employers." *Transportation Research Record 1459* (1994).

- Comsis Corporation. "Task 2 Working Paper: An Examination of Cost/Benefit and Other Decision Factors Used in Design of Employer-Based TDM Programs." TCRP Project B-4. Unpublished research findings and associated data files, Transportation Research Board, Washington, DC (1994).[2]

While somewhat dated, these studies nevertheless provide the most comprehensive set of employer and institutional TDM project examples available in which a travel change has been calculated. The calculation is based either on before and after data, or on comparison with an objective control site or measure against which to gauge a travel behavior difference.[3]

The primary travel change measure utilized is the vehicle trip reduction for the site. Vehicle trip reduction (VTR), a term commonly used in both analytical studies of TDM and travel mitigation legislation, is the percentage of vehicles removed (actual, presumed, or estimated) from a site's commute traffic load. More specifically, it is the incremental reduction achieved in the vehicle trip rate, expressed as a percentage of the starting-point trip rate. Planned and apparently successful trip reductions are reported as positive VTRs. A negative VTR indicates that the travel change appears to have been an increase in the vehicle trip rate. A VTR may be associated with TDM, land-use and site-design modifications, or related actions, although TDM per se is the subject of this chapter.

VTR may be computed from mode shift data if one knows the before-and-after carpool occupancy rates and the amount of trip suppression attained from CWW and telecommuting strategies.

[2] TCRP Project B-4, "Cost-Effectiveness of TDM Strategies," is an important TDM research project whose detailed findings were never formally published. This project was centered on a national survey of 50 employers (49 officially accepted) covering the details of their TDM programs. The sample was designed to include employers of all sizes, basic industry groups including institutions, locations within or outside urban areas, presence or lack of a regulatory requirement, and various types of strategies within programs. Extensive analyses were done with the survey data, including the effect of both program strategies and environment on vehicle trip reduction, reasons for engaging in TDM, sources of information for program design, changes made over time and compelling circumstances for the change, and costs and benefits. The initial analysis was documented in the identified "working memo" and technical appendices, but the review panel opted to frame the final report in a less technical, more executive format. The authors of Chapter 19 have had access to this unpublished technical information, and the *TCRP Report 95* team received support for using these Project B-4 data and findings in developing this third edition Handbook.

[3] Slightly different methods were used by the three studies to establish a baseline against which to gauge the given program's presumed vehicle trip reduction (VTR). The Rutherford et al. (1994) case studies compared the given project with area-wide mode split averages. TCRP Project B-4 selected as its datum the area modal split from the 1990 Census Transportation Planning Package (CTPP). The earliest study—Comsis and ITE (1993)—used a variety of comparative methods depending on data availability. These included before-and-after survey information, comparison against a local peer site of similar character but without a formal TDM program, or transportation mode split taken from regional model estimates for the subarea. Occasionally one of these methods gives an individual trip reduction value that is open to question (key instances are highlighted in chapter footnotes). Overall, however, the approaches used are a reasonable response to difficult data constraints. For simplicity, travel differences relative to the baseline are referred to in this chapter as vehicle trip reduction (VTR) although in fact most are inferred by comparison against the selected baseline.

Successful vehicle trip reduction does not necessarily infer less traffic than before. VTR is a dimensionless rate, referring to the reduction in vehicle trips from what they would have been without the TDM or other travel mitigation strategy.

There are a combined 80 different project examples provided by the three primary studies listed above. A fourth study (Comsis et al., 1996) provided two of the examples. These examples cover a wide range of situations in terms of employer type and size, setting, and composition of TDM program. Using this collection of cases as an analysis platform, the approach taken in this chapter is along the lines of a descriptive analysis. Namely, for this reasonably large and diverse sample of employer and institutional TDM projects—for which there is fairly reliable and complete data—an analysis has been structured that partitions the examples into cases that do versus cases that do not have a particular TDM element or other characteristic. The evaluation then attempts to infer the *relative* importance of particular categories of TDM strategies (e.g., support versus incentives), and even to some degree of particular strategies (e.g., a transit subsidy versus an HOV parking discount), through pair-wise comparisons from the sample. Unweighted project averages within categories are used in these comparisons.

This approach is used to examine each of the four basic TDM strategy groupings: employer support, transportation services, financial incentives, and alternative work arrangements. This 82-program sample becomes the basis or starting point for the analysis in each of the program areas. To the extent that there is sufficient clarity about an individual TDM strategy—either from the 82 examples or, more often, a supplemental study out of the literature that focuses on that strategy—additional detail about the nature and impact of that strategy is provided.

There are four major caveats in the primary approach of this analysis, which uses the sample of 82 programs as a basis. First and foremost, in no way should these 82 examples be construed as a *random* sample of TDM programs. While there are a number of examples that are fairly average in their impact, many of the examples were originally selected because they were distinct in some way—often because they were regarded as success stories. Hence, the performance of this group of programs should not be looked upon as being "typical." As a group, they are probably considerably above average in effectiveness relative to what one would expect to find in a large random sample of programs.

Second, even though there can be reasonable confidence about the quality of the data for this sample, the "pairwise" approach used in evaluation is a very simplistic means for trying to quantify the impact of individual strategies. The only way that one can begin to discern the relative impact of any given strategy is through a multivariate statistical approach, such as regression. Unfortunately, the data in this sample are too coarse and too aggregate to enable such a statistical approach, so one is resigned to trying to learn as much as possible from the data available, acknowledging the many shortcomings. Later in the report, in the "Related Information and Impacts" section, the results of two research studies that have attempted to apply more advanced statistical methods to this task are presented, though both were ultimately limited by the same data issues outlined here.

Third, except where before and after data is available and exogenous influences are known, causality is only inferred—not demonstrated. It is presumed that observed travel differences are largely caused by the TDM measures in place, but there is no analytical proof. In discussion, the terms "implied" or "inferred" are occasionally inserted as a reminder that the effect is presumed, not proven. Indeed, a majority of the VTR outcomes presented are not direct observations but rather estimates/inferences based on comparison with control sites or areas.

Fourth, there is a particular limitation specific to those alternative work arrangements actions designed to reduce the absolute number of commute trips involved. The two actions affected are telecommuting and CWW. The nature of the travel data collection affecting all 82-program samples was such that numbers of trips eliminated outright by telecommuting one or more days a week or by reducing the number of workdays by compressing work weeks cannot be ascertained. Thus outcome analysis based on the 82-program sample can only address effects of associated mode shifts, exclusive of trip elimination effects. Other available evidence must be drawn upon to obtain a full picture of telecommuting and CWW effectiveness.

Finally, a reminder as to the role of Chapter 1, "Introduction," is in order. Chapter 1 not only outlines development of the Handbook, it also provides important technical guidance in its "Use of the Handbook" section. One example of the helpful material included is the tabulation, in Appendix B, of U.S. Consumer Price Index factors for conversions to constant dollars. These may be applied to give up-to-date context to price and cost data in cited studies from various time periods.

Traveler Response Summary

Examples of effective TDM programs—defined as having a measurable trip reduction—may be found in all types of environments. Nevertheless, those employers or institutions located near good transit service have been found to have better-performing programs than those not close to good public transit. In the mostly exemplary 82-program sample of employers, the sites with high transit availability had an average program-level vehicle trip reduction (VTR) of 26 percent, compared with 12 percent where transit availability was low.

Employer Support Actions

Employer support actions are by far the most commonly-applied TDM strategies, providing a necessary—but not alone sufficient—ingredient for TDM program success. They cover providing better information on travel alternatives to employees, offering assistance in seeking out and using those alternatives, and marketing and promotional activity to persuade experimentation and use. Common measures in this group include commuter information services, employee transportation coordinators, rideshare matching, transportation fairs, on-site transit pass sales, and guaranteed ride home. One of their important benefits is an increase of employee awareness about TDM-related alternatives to driving. Employee awareness of individual incentive and assistance programs in support of alternatives has been found to range from 77 percent down to 15 percent aware.

The average empirically based estimate of site-specific vehicle trip reduction impacts for full-scale employer support programs alone is on the order of 4 to 5 percent VTR. Such estimates tend to be drawn from programs that are exemplary more often than not. Employer support programs actually have the most consistently significant impact where transit accessibility is low, making non-transit alternatives critical. Support programs are most appropriate and productive when implemented in conjunction with tangible actions such as provision of transportation services, management of parking supply and price, financial incentives, or combinations thereof. What is also clear is that simply adding "more" employee support measures to an existing solid but basic support-only program will have limited additional trip reduction benefit, but will generally raise the cost of the employer's program effort.

Guaranteed Ride Home

Guaranteed Ride Home (GRH) is a unique form of employer support action. It is effectively a standby transportation service—insurance that an employee who chooses an alternative to driving alone to work has a low- or no-cost recourse when faced with an unanticipated need to get home at a time when his/her alternative mode is unavailable or inadequate. GRH effectiveness remains somewhat of an enigma, in that empirical quantitative data on its travel impacts are scarce and not sufficiently informative. The handful of empirically-based and modeled estimates of GRH impact ranges from nil to upwards of 5 percent VTR. (The employer support actions average impact estimate provided immediately above is inclusive of GRH effects.) In any case, a good logical argument can be constructed for the role of GRH as an effective TDM catalyst, and with appropriate limits, it is relatively inexpensive to provide.

Employer Transportation Services

Employer transportation services include employer assistance with vanpool creation and program management, transit assistance either in the form of running separate shuttles or contracting with the transit operator to intensify service, or allowing use of company vehicles for ridesharing or mid-day business trips. In the 82-program sample of employers, those TDM programs which provided transportation services were considerably more effective as a group in reducing vehicle trips (22 percent program VTR) than those that did not (14 percent), an 8 percentage point advantage.[4]

The benefit of transportation services is enhanced in the presence of modal subsidies (monetary incentives linked to use of the preferred alternative modes) and is damped without modal subsidies. The synergy between transportation services and modal subsidies is both obvious and strong. Programs in the 82-program sample with services but without modal subsidies averaged slightly over 9 percent VTR, while programs with both achieved just under 27 percent VTR, almost three times as much. In a well-studied exceptional case with time-series data available—a Tennessee Valley Authority program of the 1970s—the VTR for a multimodal transportation services program (aided by a gasoline shortage) was 25 percent, increasing to 51 percent with the addition of modal subsidies, a doubling of effectiveness.

Incentives and Disincentives

Among inducements to use alternative modes, incentives and disincentives encompass a variety of TDM strategies that constitute "incentives." These may in turn be separated categorically into non-monetary incentives and monetary incentives. Non-monetary incentives include such strategies as preferential parking, awards, or other special treatment, while monetary incentives are those that have a tangible dollar value to the employee. Even this distinction still blurs somewhat in strategies where the financial benefit to the employee is somewhat diffuse, such as prizes and raffles or time off with pay. The most tangible financial incentives are either modal subsidies or travel allowances, where the association between the incentive and the behavior is visible and direct. Of course, the incentive must logically be relevant to the travel alternatives available at the site. Many employers offer their employees a transit subsidy simply because of its tax-exempt advantage, although in many cases transit is not a viable commute alternative.

In the 82-program sample, those employers who featured transit subsidies in their TDM programs had an average VTR of 21 percent, versus 14 percent for those who did not. Carpool subsidies, per se,

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[4] All VTR findings reported from the 82-program sample examination include the effects of not only the TDM strategy being discussed (with or without employer transportation services in this case), but also all other TDM actions that may have been in place within the particular programs in question (in this instance, the 34 programs with employer transportation services on the one hand and the 48 programs without services on the other).

were not found to be common, but employers who offered them as part of their programs averaged a 23 percent trip reduction versus 17 percent for those who did not. HOV parking discounts were a much more prevalent form of subsidizing carpooling, and those programs averaged 26 percent trip reduction versus 14 percent for those who did not. Travel allowances, which include parking cash-out, were still an early concept when the 82-program sample data were assembled in 1990–1993 and are not well represented in the data set. A 1997 review of eight California parking cash-out programs found an average decline in vehicle trips of 17 percent.

In the realm of "disincentives" to driving, the management of employer parking can play an important role. Through controlling parking availability, price, or both, parking management has a major effect on TDM program success in reducing vehicle travel. The impact is similar in magnitude to the supportive effect of good transit availability, and the two are most commonly found together. Those employer TDM programs in the 82-program sample that were accompanied by restricted parking had average VTRs of 25 percent. If the parking was also priced with parking fees, the average VTR increased to 28 percent, and if discounts were also offered to carpools or vanpools, the average VTR was 30 percent.

The combination of parking fees and employer transportation services produces a particularly strong synergistic effect, with the average of such combinations within the 82-program sample exhibiting an implied 37 percent VTR. The University of Washington U-PASS program combines parking pricing, transportation services, and modal subsidies, and has obtained a 31 percent VTR as measured with time-series data over a span of 16 years. Clearly, if it is more difficult or costly to drive, TDM alternatives become more attractive.

Alternative Work Arrangements

Alternative work arrangements constitute the final major category of TDM strategies. They include flexible work hours, staggered work hours, compressed work weeks (CWW), and telecommuting. An important finding has been that the only work hours strategy with a measurably positive effect on choice of alternative commute modes is flexible work hours. In many cases use of flexible work hours has been restricted to employees using alternative modes, which may help explain the synergy. In the 82-program sample, employer programs that included flexible work hours averaged a VTR of 20 percent compared to 13 percent for other programs, a difference that may or may not be wholly attributable to the work hours strategy.

CWW and telecommuting are the only TDM strategies intended to lead to outright elimination of commute trips by whatever travel mode. CWW programs achieve this with more hours per work day and correspondingly fewer work days per week or two-week period. A comprehensive 1980s experiment in Denver involving 9,000 federal employees found the longer work day flattened the peak, reducing the peak 1/2 hour from 56 to 42 percent of all arrivals; had no adverse effect on ridesharing or transit use; and reduced vehicle miles of travel (VMT) by a net 15 percent among participating employees. Employee participation in the program was 65 percent.

Telecommuting has yet to live up to its anticipated theoretical promise as a TDM measure. Surveys indicate that employees who telecommute from home avoid a physical commute about 1.8 days a week on average. A Washington State analysis of the special case of telework centers found 83 percent drive-alone mode shares for the daily telework center commute compared to 56 percent for these telecommuters on days they went to the main work site, detracting from telework center efficacy. A 1998 synthesis-type study of telecommuting overall estimated, starting with empirical observations, that a regional program would reduce employee VMT by 1 percent or less—and perhaps not at all—depending on residential relocation decision assumptions. Newer evidence does not contradict the vehicle trip reduction basis for this estimate, though a slow, steady growth of telecommuting has been seen.

The trip timing decisions employees make when given the option of flexible work hours have been found in most cases to be as effective as mandatory staggered work hours in spreading out work arrival and departure times, although the 1980s Bishop Ranch and Pleasanton suburban programs in California stand as exceptions. A large-scale urban program could smooth traffic peaks enough, in the 1970s, to reduce maximum 15-minute passenger and vehicular loads by 15 to 35 percent at terminal facilities such as rapid transit stations and major parking lots. The effects dissipate, becoming diluted by 50 percent or more, on radial facilities serving the involved employment core. It is not known to what extent the gradual adoption of flexible work hours in recent years may have reduced the remaining potential for peak spreading by shifting the baseline starting point for concentrated alternative work arrangements programs.

Site-Specific and System-Level Impacts

Site-specific impacts are the focus of this chapter, but it is important to understand the relationship with area-wide, regional, and system-level impacts of employer TDM programs. As one moves from the site level toward the broader area-wide or regional transportation facility level, dissipation of site-specific impacts occurs. Effectiveness is leveled out among differing participating employers and institutions, averaging out big and small employers and high- and low-effectiveness programs. Participating employer commuting is mixed in with commuting to and from non-participating employers. Mixing also occurs with passenger and vehicular flows associated with non-work activities either at the site or at other nearby land uses. Further leveling-out of impacts occurs as locally generated trips become mixed on specific facilities with other intra-regional travel and even intercity travel in the case of major highways.

A limited number of estimates have been made of actual and potential regional and system-level impacts of employer and institutional TDM strategies. In the Minneapolis-St. Paul airport area, for example, it was estimated that TDM with limited mandatory involvement and strong parking management combined with mixed-use development would offer an 8 to 27 percent VTR at participating sites, a 6 percent average workplace VTR, and a 2 percent peak-traffic reduction on adjacent I-494. Another examination of potential regional impact calculated that only 13 percent of daily VMT would be affected by a mandatory TDM program, and went on to estimate that a 25 percent increase in average vehicle ridership (AVR) at involved employment sites would produce a 2 to 3 percent reduction in regional vehicle trips and a 3 to 4 percent decrease in regional VMT. An evaluation of actual 2003 Commute Trip Reduction (CTR) mandatory TDM program effects along an 8.6 mile centrally located section of I-5 in Seattle estimated that the average VTR at 189 involved employers was between 11 and 14 percent. Traffic simulation was then used to project that absent the TDM programs, peak-period I-5 ramp volumes would increase by about 4 percent, peak-period traffic congestion would be up from 23 to 44 percent, and corridor peak-period vehicular emissions would rise on the order of 11 percent.

RESPONSE BY TYPE OF TDM STRATEGY

This section examines the response of travelers to implementation of various employer and institutional transportation demand management (TDM) strategies. To the extent possible, what is known as to the effect of individual strategies on such key travel measures as vehicle trip generation/

trip reduction, vehicle miles of travel, mode split changes, vehicle occupancy, or time of day/ frequency—where relevant—is reported. Historically, TDM response findings have been difficult to derive in this detail, since strategies are frequently implemented in often unique groupings or packages, are not monitored in a manner that facilitates travel impact research, and may be changed or offered to different groups of employees.

As noted earlier in the "Analytical Considerations" subsection, the approach that has been used by the Handbook authors to explore the relationships between particular types of TDM strategies and traveler behavior depends heavily on the detailed examination of a sample of 82 employer and institutional TDM programs (the 82-program sample). These project examples have been drawn primarily from three separate research studies, selected for comparable detail on program description and measurement of travel impact. A listing of these individual programs, along with the employer characteristics, TDM strategies encompassed, and computed travel impact, is provided as Appendix Table 19-A.

Travel impacts in this analysis are gauged by the inferred change in average vehicle trip rate. The vehicle trip rate is the number of vehicle trips made by the employees commuting to a given work site in relation to the total person trips to the site, expressed in Appendix Table 19-A in the form of average daily vehicle trips per employee. (See Footnote 1 in the "Analytical Considerations" discussion above for alternative vehicle trip rate units of measurement.)

By comparing the vehicle trip rate of the employer with the TDM program relative to the vehicle trip rate measured either before implementation or as some other control rate representing background conditions, one may interpret the change or difference in trip rate as a vehicle trip reduction (VTR) attributable to the TDM program. Control rates employed by the source studies include a similar employer in the adjacent area, the average performance for a sample of employers in similar physical settings, or the average vehicle trip rate for the local area derived from modal split information in the Census Transportation Planning Package (CTPP) for the nearest comparable time period.

Even though the sample of projects used for this assessment is viewed as the most robust data resource available in terms of program detail and impact measurement, the types of analyses and conclusions it allows are still quite limited. There are also important caveats to keep in mind when making use of findings drawn from it. These were enumerated at the conclusion of the "Analytical Considerations" subsection within the "Overview and Summary."

The basic analysis consists of comparing VTR for a group of employers who have a particular TDM element with those who do not. For this comparison to be statistically valid at demonstrating the actual effect of the given element, it would be necessary to assume that everything else about the two groups being compared is the same, apart from this element. Clearly, this is a big assumption given the diversity of the examples highlighted in Appendix Table 19-A. In very large samples (as in epidemiological studies), the randomness with which these other characteristics occur can be assumed to produce fairly comparable samples, and hence determining whether the difference between the means is real can be addressed with statistical reliability tests. In the case at hand, however, a relatively large sample of TDM programs is still small statistically in terms of all of the sources of internal and external variance, particularly given the small number of observations in some analysis cells.

As a result, the relationships presented here should be regarded as primarily descriptive, although in some instances the differences are so great that one may begin to suggest that the particular element surely must be influencing the outcome. The nature of this analysis is to begin to show what types of actions appear to be the most influential, and what underlying factors may complement or detract from the inferred effect.

The key employer characteristics of the 82-program sample are as follows (size of sample sub-set shown in parentheses):

- Employment Type:
  – Professional/Office (25)
  – Commercial/Service (8)
  – Manufacturing/Industrial (14)
  – Government (10)
  – Utility (8)
  – Medical Institution (6)
  – University (4)
  – Miscellaneous Research or Non-Profit Institution (7)

- Number of Employees:
  – 10,000 or more (8)
  – 5,000 to 9,999 (7)
  – 1,000 to 4,999 (26)
  – 500 to 999 (5)
  – 100 to 499 (34)
  – less than 100 (2)

- Location:
  – Central Business District (CBD) (14)
  – CBD Fringe (9)
  – Suburban CBD (14)
  – Suburb (10)
  – Office Park (13)
  – Campus (12)
  – Exurban/Rural (10)

- Transit Availability:
  – High (24)
  – Medium (18)
  – Low (40)

- Parking Conditions:
  – Restricted Parking (34 with, 48 without)
  – Parking Fees (30 with, 52 without)

Inferences from the 82-program sample are presented together with results of synthesizing available TDM travel demand impact studies and research. In most instances the one is supportive of the other, but in some cases disparate findings illustrate inability to draw definitive conclusions and corresponding need for further research.

Response to Support Actions

Support actions are arguably the most basic initial strategies an employer can implement when creating an employee TDM program. Frequently, low utilization of alternative modes for commuting or of alternative work arrangements such as telecommuting or CWW is a result of low awareness and poor information. Several studies have shown that even in an employment setting where the employer is offering a wide array of transportation options and benefits, a substantial percentage of employees are unaware or under-informed regarding the nature and availability of these options. This aspect of *awareness* is covered in more detail in the "Individual Behavioral and Awareness Considerations"—"Awareness and Comprehension of Options" discussion within the "Underlying Traveler Response Factors" section. A primary function of TDM support actions is to increase knowledge and awareness, not only of reasons why changing commute habits is important, but—most importantly—what means exist to make that change and what advantages may come to the employee for changing.

However, as important as support actions are for directing attention to an employer TDM program, many programs rely too heavily—or even exclusively—on support actions while ignoring measures shown to produce more substantive behavioral change. Support actions are perhaps best viewed as a catalyst—important in stimulating the reaction, but generally with a minimum role in the reaction itself. Regardless, many employers or institutions have tried to use a rigorous program of marketing and promotion to raise employee consciousness levels, hoping to change the "culture" in accepting alternative choices.

Support Action Insights from the 82-Program Sample

Because there are so many TDM strategies that fall in the category of support actions, and with countless combinations and renditions of those strategies, a typology has been used to examine the relative effectiveness of different levels of employer support. The 82-program sample has been categorized into levels of high, medium, and low support, based on the range of strategies employed and the level of intensity with which they are applied.

In general, a low-support program is one in which the employer shows little or no active effort in promoting alternative commuting habits to employees. For example, such employers may allow employees to participate in rideshare matching or allow the transit agency to drop off literature, but will not themselves get involved in the process. In a medium-support program, by the definition used here, the employer makes a conscious effort to get involved. There seems to be good spirit behind providing information about commute options and programs (inside and outside the organization), an employee transportation coordinator is appointed (even if only part time), and there is an openness to assisting with ridesharing (matching), transit (pass sales), and promoting the use of these programs. In a high-support program, the employer appears to be applying just about every strategy possible, even though in some cases the applicability or objective may not be clear.

Table 19-1 provides an employer trip reduction performance comparison of programs that incorporate high, medium, and low levels of support actions. This is the first of a number of tables of this genre. In these tables, vehicle trip reduction strategies are cross-classified, either with each other or with ambient conditions such as transit availability. Drawing from the 82-program sample, the VTRs of programs that match each of the strategy/strategy or strategy/condition combinations defined by the table's columns and rows are averaged using unweighted computations. These program average VTRs are the percentage values displayed in each cell of the table defined by the column and row strategies/conditions.

Just below each VTR, in parentheses, is the number of programs out of the 82-program sample that have met the combination criteria and have been used in calculating the average. In the tables these counts are identified as sample size. It is crucial to remember that the VTR convention is to show vehicle trip reductions (or the degree to which vehicle trips are less than in baseline sites) as positive numbers, reflecting that vehicle trip reduction is the TDM objective. The occasional negative

VTR implies that the average in question reflects vehicle trip rates actually greater than the average baseline values with which they were originally compared.

As an example, take the "28.4%" value near the upper left-hand corner of the table. It is in the high employer support level column and the high transit availability row. Below it is the sample size of "(10)." This indicates that out of the 82-program sample, 10 programs have been found to be characterized both by a high level of employer support actions in their TDM programs and location in areas of high transit availability. The simple average VTR of these 10 programs has been calculated to be 28.4 percent. The fact that it is positive suggests success in trip reduction in connection with the high-transit-availability location of the 10 sites, the high level of support actions applied, and also (importantly), whatever other TDM actions these particular 10 programs may have also included. The VTR value may be compared with others in the table to begin to infer the effect of different combinations of TDM actions and situations.

In the "All" row, Table 19-1 first compares VTR performance with reference to the level of employer support actions included in the programs. The table then connects the support program levels with other important characteristics of the sites or of the TDM programs. Looking only from the perspective of level of support, the data suggest that employers or institutions offering high levels of support in their programs, with a 19.0 percent average VTR, performed better than medium-level support (15.9 percent VTR) and low-level support (15.0 percent VTR) programs.

Table 19-1 Vehicle Trip Reduction Percentages Related to Support Actions and Levels

Other Conditions	VTR by Level of Overall Employer Support (Sample Size)			
	High	**Medium**	**Low**	**All**
All	**19.0%** (32)	**15.9%** (33)	**15.0%** (17)	**16.9%** (82)
Transit Availability				
High	28.4% (10)	28.2% (6)	24.3% (8)	26.0% (24)
Medium	10.1% (5)	15.3% (10)	3.2% (3)	11.9% (18)
Low	15.9% (17)	13.6% (17)	8.6% (6)	12.3% (40)
Restricted Parking				
Yes	29.9% (12)	23.8% (11)	18.0% (11)	24.1% (34)
No	12.5% (20)	12.0% (22)	9.6% (6)	11.9% (48)
Parking Fees				
Yes	24.4% (14)	27.3% (7)	22.8% (9)	24.1% (30)
No	12.5% (18)	12.0% (26)	9.6% (8)	11.9% (52)
Transportation Services				
Yes	26.5% (15)	15.5% (14)	24.2% (5)	21.6% (34)
No	12.4% (17)	16.2% (19)	11.2% (12)	13.6% (48)
Modal Subsidies				
Yes	20.5% (26)	19.8% (25)	16.9% (13)	19.5% (64)
No	12.7% (6)	3.7% (8)	9.1% (4)	7.9% (18)
Telecommuting				
Yes	16.6% (10)	14.6% (6)	28.2% (1)	16.5% (17)
No	20.1% (22)	16.2% (27)	14.2% (16)	17.1% (65)
Compressed Work Week				
Yes	19.7% (15)	21.5% (10)	8.3% (3)	19.5% (28)
No	18.4% (17)	13.5% (23)	16.5% (14)	15.8% (54)

Sources: Derived (see Appendix Table 19-A) from Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

What is not reflected in this simple comparison, however, is the extent to which the performance of high-level programs is influenced by packaging with other high-impact strategies, such as parking fees or modal subsidies. This question is further explored in the following discussion, in parallel with Table 19-1. It will be shown that support actions have less effect than either ambient area transit service levels or programs involving parking management/pricing, transportation service provisions, or modal subsidies.

Transit Availability. Sites with high transit availability show a rather small difference between high- and low-support programs (28.4 percent versus 24.3 percent VTR), but there is a marked difference between sites with high and low transit availability, regardless of the support program level. The difference between high and low transit availability sites with high support is 28.4 percent versus 15.9 percent VTR, while the same comparison for medium-support sites is 28.2 percent versus 13.6 percent, and for low support it is 24.3 percent versus 8.6 percent. Interestingly, though, the implementation of higher-level support programs when transit service is limited seems to have more of a benefit—while the difference between low- and high-support programs when transit availability is high is only 4.1 percentage points[5] (24.3 percent versus 28.4 percent). The difference is 7.9 percentage points (3.2 percent versus 10.1 percent) for medium transit availability and 7.3 percentage points (8.6 percent versus 15.9 percent) where transit availability is low.

Incentives and Disincentives. A similar result may be seen in relation to support actions in programs with incentive and disincentive characteristics such as restricted parking, priced parking (parking fees), or where the employer provided transportation services or modal subsidies. In each of these cases, the difference in VTR between employers who had any of these TDM program elements and those who did not is significantly greater than the corresponding difference associated with different support levels. Clearly, higher support levels are associated with higher rates of trip reduction in most of these cases (all cases if the comparison is restricted to high- versus low-support levels), but the effects are small relative to the impacts of the other types of strategies in the comparison.

Alternative Work Arrangements. Higher levels of support programs seem to enhance trip reduction in combination with both telecommuting and CWW programs, as they do in cases without telecommuting or CWW, though the modest positive effect on trip reduction is not entirely consistent between individual support levels. Note that, as previously cautioned, data from the 82-program sample are not capable of reflecting the full range of telecommuting and CWW impacts. A full discussion of how these alternative work arrangements perform as strategies is provided in the subsection on "Response to Alternative Work Arrangements." It should be consulted before attempting interpretation of the "Yes" versus "No" telecommuting and CWW comparisons in Table 19-1.

Additional Evidence of Individual Support Action Effects

Information, Marketing, and Promotion. As suggested earlier, for a TDM program to succeed, several conditions must be present. In the case of persuading employees to switch modes or adopt an alternative work schedule, they must: (1) be convinced of the inherent value of changing their behavior; (2) have access to the type of information that allows them to understand their options, which also means being made *aware* that their employer offers particular options; and (3) be motivated to test and ultimately continue using the recommended options. This is rightly seen as the role of marketing and promotion.

[5] "Percentage points" refers to an absolute difference in percentages, rather than a relative difference.

An example of the possible effects of active marketing, promotion, and information campaigns on commute behavior is offered by a "Transportation Days" experiment in the Cross Westchester Expressway Corridor of New York State in the early 1990s. Rapid employment growth in the corridor in the late 1980s was resulting in severe traffic congestion, causing the New York State Energy Office to award a grant to the Westchester County Department of Transportation to develop and implement transportation management programs to save energy, and reduce congestion and air pollution. The resulting public-private effort included targeted transit service improvements coupled with marketing of alternatives and information on their availability and use. The information was presented throughout 1992 at 79 different employer locations in the corridor, representing about 12,000 of the corridor's estimated 100,000 employees.

Before-and-after employee surveys showed that about 17 percent of the targeted employees attended the promotional events. Of these, about 32 percent changed mode in the subsequent year, although the changes were not uniformly from drive-alone to alternative modes. However, among promotional event attendees, single occupancy vehicle (SOV) use fell from 68.6 percent to 63.7 percent—an almost 5 percentage point reduction—while among those who did not attend, SOV use increased from 68.9 percent to 70.8 percent, an increase of almost 2 percentage points. What is unclear from these results is whether the people who attended the promotion were different in some way, such as more in need of a transportation alternative, and how stable these choices were over time, given that the follow-up survey was conducted within 1 year of the promotion (SG Associates and Howard/Stein-Hudson Associates, 1993; Spielberg et al., 1993). This program is covered in more detail later in the "Case Studies" section (see " 'Transportation Days' Marketing and Outreach Programs—Cross Westchester Expressway Corridor").

In a 1993 study for the California Air Resources Board (CARB), it was found that a surprising percentage of employees were unaware that their employer offered a particular type of TDM strategy. While 1/2 to 2/3 of employees were aware of employer-offered measures such as preferential parking (77 percent), rideshare matching (70 percent), company vanpool vehicles (67 percent), and rideshare prizes (64 percent), much smaller numbers were aware that their employer conducted transportation fairs (15 percent), or offered bus pass discounts (17 percent), on-site pass sales (41 percent), or guaranteed ride home (36 percent). These findings were a revelation to CARB and to the participating employers, and argued strongly for more aggressive information and marketing efforts as part of the programs (Comsis, 1993a). For tabulation and further discussion of these awareness level findings see "Individual Behavioral and Awareness Considerations"—"Awareness and Comprehension of Options" within the "Underlying Traveler Response Factors" section.

Employee Transportation Coordinators (ETCs) are a popular strategy for performing this information and promotional function. Most of the example programs in the 82-program sample incorporate ETCs, either on a part-time or full-time basis. The time investment required for an ETC is a function of the size of the employer, the complexity of the given program and local travel alternatives, and the pressure felt by the employer to have its program succeed. In addition to interacting with employees, ETCs are also the point of contact with outside programs and agencies, such as regional ridematching, transit, or a Transportation Management Association.

CUTR's National Center for Transit Research performed a study to try to determine the importance of an ETC in the success of an employer TDM program, while at the same time accounting for differences in management support and factors like transit availability. Based on a review of 13 work sites in the Puget Sound area, the study reached an interesting, almost dichotomous conclusion: ETCs are necessary for a successful work site trip reduction program if the work site is not located in an area with access to high quality public transportation, but are not necessary if the work site is located in an area with good public transportation and the employment base consists of lower-income staff who must choose transportation cost savings over time savings and convenience. The study further concluded that, in a successful program, top management backs up these factors through support such as the provision of meaningful incentives (Hendricks and Joshi, 2004).

Guaranteed Ride Home. A strategy appearing to address an important concern of employees considering use of an alternative commute mode to reach a work site is Guaranteed Ride Home (GRH). Numerous surveys have suggested that having the assurance of a back-up mode that can be used in the event of a personal emergency or unplanned schedule change can be the "deal clincher" in getting an employee to switch from driving alone. The issue from an evaluation perspective is determining just how important a "supporting" strategy like GRH is in the overall trip-making decision process, and what portion of vehicle trip reductions can be directly attributed to this strategy.

An examination of 11 GRH programs throughout the United States, representing many different program types, scales, and settings, found—in general—strong intuitive support for GRH among the program managers. The evaluation was, however, unable to statistically support or reject the contention that GRH services actually encourage ridesharing. This situation was attributed to a frequent lack of adequate before-and-after data and the fact that GRH was usually implemented concurrently with other incentive programs, making it difficult to attribute changes in alternative mode use exclusively to the GRH service (Polena and Glazer, 1991).

In its 2001 State of the Commute Survey, the Metropolitan Washington Council of Governments (MWCOG) found that 31 percent of commuters who decided to use a non-drive-alone mode felt that GRH was very important to their decision, while 33 percent said it was somewhat important and 36 percent said that it was not at all important. Asked another way, 20 percent said that they would be 100 percent likely to use an alternative mode even if GRH were not available, 48 percent said they would be very likely, 23 percent said they would be somewhat likely, and 8 percent said they would be not at all likely (MWCOG, 2002).

A 1994 review of a GRH program demonstration conducted in the Baltimore/Washington International Airport Business District reached a similar set of conclusions. These responses suggest that despite a highly favorable view of GRH, evaluation of its importance in actually determining a shift in mode must consider that only a small percentage of employees making a shift (8 percent) would be unlikely to make the change without GRH.

Under the 12-month Airport Business District experiment, a registered program participant would notify his/her supervisor of the emergency or overtime requirement and directly call one of the participating service providers (a taxi company and a rental car company). The service, which was available 24 hours a day, was provided within 30 minutes, with the user permitted to make en route stops related to the emergency. The fare was passed directly on to the administrating agency (BWI Partnership). The number of participants grew steadily from 241 to 732 over the course of the program, amounting to roughly 25 percent of eligible employees. In all, 114 participants (15 percent of all participants) used the GRH program for a total of 287 trips. The majority of users made only one GRH trip, with the average number of trips per user being 2.5. Forty-five percent of the GRH trips were for unexpected overtime, while the remainder were for personal or family emergencies.

The evaluation of the program concluded that there was no reliable evidence that the GRH program directly increased alternative mode use in the study area, although it may have helped retain existing alternative mode users. Analysis of commute behavior before and after the demonstration indicated that overall it remained virtually unchanged. Surveys revealed a decrease of less than 1 percent in SOV use and a 1 percent increase in High Occupancy Vehicle (HOV) and transit use over the course of the project. Some 58 percent of those respondents who changed their mode during this time period said that the GRH program was not an important factor in their choice (Jewell and Schwenk, 1994).

An evaluation of the impact of trip reduction requirements for the City of Sacramento suggests a different result. Looking at annual employer and employee travel survey data compiled by the city, covering 58 employers and roughly 26,000 employees, vehicle trip rates were compared for the 38 employers who offered GRH with the rates of the 20 employers who did not. An increase in carpool mode share by an average of 4.6 percent was found at the employers offering GRH as compared to only 1.6 percent at those where it was not offered. Similarly, an increase in vanpool share of 1.7 percent was found in the presence of GRH versus a decline of 0.2 percent otherwise, along with an increase in transit share of 1.2 percent when GRH was offered versus a no-GRH decline of 0.1 percent. These findings correspond to an average VTR of 7.3 percent in the programs where GRH was offered versus only 1.7 percent in those where it was not, suggesting a net VTR effect of 5.6 percentage points for GRH (Schreffler, 1997). Of course, as with the Handbook authors' own pairwise analysis of the 82-program sample, other characteristics of program or setting that may have influenced this result are not known.

Support Action Combinations. A National Center for Transit Research study aimed at developing a "Worksite Trip Reduction Model and Manual" provides an overview of the types of employer support strategies that are most commonly employed, and roughly what role they have in TDM program effectiveness. Using data from major publicly mandated employer trip reduction programs in Los Angeles, Tucson, and Washington State, the researchers first identified the 50 most common types of program combinations that were offered by employers. They then calculated the average VTR associated with each combination of strategies. The most common support measures observed were marketing, rideshare matching, guaranteed ride home, and facilities and amenities such as bike racks, showers, and changing areas (CUTR, 2004). What was evident in comparing the different programs with regard to their composition and VTR is that while the support strategies occurred in virtually all of the program packages, the programs with the higher impacts were clearly those which also implemented financial and other incentives. This provides further support for the premise that support strategies are a necessary, but not sufficient, ingredient for a successful TDM program.

Consulting the 82-program sample once more, judgment has been used to identify those programs which were exclusively or substantially high-employer-support programs, with none or few other meaningful strategies offered. There were 15 programs that fit this definition. The programs are identified in Appendix Table 19-A as Childress Buick, K-Mart Valencia, Mercy Home Care, Hillsborough County, Rosarita Foods, Shure Bros., California Franchise Tax Board, McClellan AFB, Dean Witter, Kinko's Service Corp., Payroll One, Varian, UCLA, University of Central Florida, and AT&T Pleasanton. The average VTR for this set of programs is 4.1 percent, substantially below the average of 16.9 percent for the entire 82-program sample.

An analysis of information previously compiled by the legislatively-mandated employer trip reduction program of Maricopa County, Arizona, was prepared in 1993 for the Chicago Area Transportation Study (CATS) as an aid to developing guidelines for Employee Commute Options (ECO) program implementation in Chicago. The Arizona program had required all employers with 100 or more employees to develop a set of strategies aimed at reducing vehicle trips by 5 percent annually. The analysis looked at data on TDM measures, employer characteristics, and travel behavior changes taken from annual surveys covering the first 3 years of program operation—from inception through year 3—for 556 work sites.

Maricopa County had identified approximately 55 distinct TDM measures, and those which had been actually implemented were consolidated in the CATS analysis into 16 strategy categories. The first 10 were classified as "marketing and support" measures. Table 19-2 shows the change in Average Passenger Occupancy (APO)[6] for programs that—according to this classification system—*only* employed support and marketing strategies. (It will be noted that several of these strategies were not classified as employee support programs for purposes of this chapter's discussions.) Where a particular strategy (e.g., Bike Incentives) was one of the strategies in a package, that program is included in the tabulation under that strategy.

A percentage increase in APO may be roughly compared to a percentage increase in VTR. APO increases were found to range from 3.4 percent to 9.0 percent depending on the included strategies, with an average 4.6 percent for the group as a whole (Teal, 1993). This Maricopa County/CATS analysis suggests that 4.6 percent may be taken as a reasonable estimate of the vehicle trip reduction potential for TDM programs that incorporate only "marketing and support" strategies, an estimate very close to the 4.1 percent average VTR for the 15 support-strategy-only programs identified in the 82-program sample.

Table 19-2 Association Between "Marketing and Support" Strategies and Average Passenger Occupancy (APO) Changes in Maricopa County, Arizona

Included "Marketing and Support" Strategy	APO Increase (Pct.)	No. of Programs
Bike Incentives	5.4%	25
Bike/Walk Facilities	5.0	77
Preferential Parking	5.5	61
Carpool Matching	4.9	47
Carpool Incentives	4.3	23
Guaranteed Ride Home	5.8	74
Prizes, Rewards	5.5	75
Flexible Schedules for Alternative Mode Use	9.0	5
Transit Support Incentives	3.4	21
Information Measures	4.7	239
All (Programs with "Marketing and Support" Strategies Only)	**4.6%**	**240**

Note: The typical program had more than one "Marketing and Support" strategy, thus the last column does not add to the total number of programs.

Source: Teal (1993).

Still further corroborative evidence is provided by an analysis conducted by the Washington State Commute Trip Reduction (CTR) program. With very high statistical correlation, it was estimated that early employer TDM programs in both city and suburban locations achieved an average drive-alone mode share reduction close to 5 percentage points in the first 2 years after program implementation.

[6] Average Passenger Occupancy (APO) is the weekly total number of employee person trips divided by the weekly total of employee vehicle trips (commute trips only). A percentage change in APO may be roughly compared to a percentage change in vehicle trip rate. APO is essentially the same as AVR, except that legal definitions of AVR may introduce slight differences, such as specification of covered commute hours instead of having the computation cover full 24-hour periods.

Although records of individual program actions implemented were not assembled, the sense is that they were dominantly focused on providing information, making employees aware of their options, and offering and publicizing a guaranteed ride home (Hillsman, 2009).

An interesting supplemental analysis from the Maricopa County/CATS assessment looked at the potential cumulative benefit from multiple marketing and support measures. Many employers were found to have implemented multiple measures of this category. Table 19-3 shows the percent change in APO in relation to the total number of measures, and also the number of those measures that were "non-information" in nature (Teal, 1993).

The tabulation suggests a very modest APO improvement when the number of measures increases from 6 to 8 (APO from 5.0 percent to 5.7 percent), and again from 8 to 10 measures (APO from 5.7 percent to 6.6 percent). However, since the number of measures that are non-information is also increasing to the same extent as total measures, one is left to wonder if the very modest effect is coming solely from non-information measures. The other side of this coin is the potential inference that the primary marketing and support program effect is that associated with the information measures. Perhaps the major point to be made is that simply adding more marketing and support measures to a core marketing/support program does not appreciably enhance its bottom-line effectiveness, though in many cases it will likely add to program costs.

Table 19-3 Association between Multiple Marketing and Support TDM Measures and APO Changes

Total Measures	Non-Information Measures	APO Change	Number of Plans
5 or more	2 or more	5.0%	93
6 or more	3 or more	5.0%	88
8 or more	5 or more	5.7%	54
10 or more	7 or more	6.6%	16

Source: Teal (1993).

Response to Employer Transportation Services

It is relatively uncommon for employers or institutions in the United States to become involved in the physical transportation of their employees, and more likely that they will simply encourage them to use alternatives that are available in the marketplace. In some circumstances, however, no meaningful travel alternatives are available, such as at a remote business campus where transit does not directly serve the site. In such cases, some employers have taken the initiative to provide tangible transportation services for their employees. They may do this by:

- Arranging for bus service to the site under contract or other agreement with a public or private transit provider, or paying to augment the level or quality of a pre-existing service.
- Arranging for shuttle service to connect with a rail transit station beyond walking distance.
- Assisting in the startup, operation, maintenance, or cost sharing of a vanpool program.

- Making company fleet vehicles available for use by employees for ridesharing or site-based uses, such as travel to business meetings, errand running, or emergency trips home.

It may be argued that other types of strategies also serve as transportation services in which the employer is directly involved, such as assisting with rideshare matching, providing bike facilities and showers and/or preferential parking for carpools, or offering a guaranteed ride home. However, because these strategies generally entail less direct, physical involvement of the employer, they have been included among support actions in this chapter's typology, reflecting how they are generally regarded among TDM practitioners.

Not all employers/institutions that provide transportation services are characterized by remote/campus locations. Some become involved simply because transit service to their site or from particular employee concentrations is too limited. Some become involved in vanpool programs, as a special example, even when they are located in an urbanized setting near transit, simply because they feel it best suits their company ethic or policies, or because they judge more employees can be served effectively through such a program.

Employer Transportation Services Insights from the 82-Program Sample

Table 19-4 examines the employers in the 82-program sample that had transportation services as part of their TDM program. As with the support actions assessment, the table is developed from information displayed in Appendix Table 19-A. It shows the average VTR associated with particular groups of employers and the number of employer examples in each category.

For convenience, the employer transportation efforts are divided into four groups: those who provided transit assistance, those who provided vanpool assistance, those who provided both transit and vanpool assistance, and those who provided company vehicles for employee use. The last two columns summarize and compare the programs of all employers providing services with those who did not. Finally, trip reduction impacts are presented in relation to such elements as transit availability, restricted parking, parking fees, level of support program, modal subsidies, and the alternative work arrangements of telecommuting and CWW. This is done to gauge the importance of transportation services in relation to other program strategies or site conditions and of any synergistic effects of combining these actions/conditions.

One thing Table 19-4 indicates is that 34 of the employers in the 82-program sample, or 41 percent, offered one or more types of transportation service. Of these, four programs exclusively provided transit service assistance, 11 exclusively offered vanpool assistance, 11 provided both, and 11 allowed use of company vehicles. Of this latter group of 11, eight provided for use of motor vehicles, two provided loaner bicycles, and one provided both. In addition, three of the 11 sites offering company vehicles did so in combination with other transportation services: two provided for company motor vehicle use in conjunction with vanpool assistance, and one provided both motor vehicles and bicycles in conjunction with transit assistance.

In general, the programs where employers offered transportation services have better performance than those that did not. Looking at the summary row in Table 19-4 marked "All," it may be noted that the average VTR of the 34 employers who provided transportation services is 21.6 percent, in comparison to 13.6 percent for the 48 employers who did not provide services. Among the different types of transportation services provided, programs offering company vehicles for uses supportive of not driving to work alone rank highest, with an average VTR of 24.6 percent. These are followed by vanpool assistance at 21.3 percent, and transit and transit–plus-vanpool at 18.9 percent and 18.8 percent, respectively.

Looking at the combination of these transportation service programs with other employer TDM elements or site conditions yields the following insights:

Transit Availability. Not surprisingly, the largest number of instances where employers offered transportation services is where transit availability was low. Seventeen of the 34 employers providing services fell in this category, and virtually all of them attempted to compensate for the absence of transit by providing vanpool assistance, either by itself (six employers, averaging 18.6 percent VTR), or in combination with transit (seven employers, averaging 16.1 percent VTR). The best-performing programs in this low transit availability category are the six that provided use of company vehicles, averaging 21.8 percent VTR. As a whole, the programs in this low transit availability category only account for an average VTR of 15.5 percent—below the average of 16.9 percent for the overall sample of 82 sites, and only 4.4 percentage points better than the average of 11.1 percent for the 22 programs in this category that offer no services.

Table 19-4 VTR Percentages Related to Employer Transportation Services Provided

	VTR by Type of Transportation Service (Sample Size)					
Other Conditions	**Transit**	**Vanpool**	**Transit & Vanpool**	**Company Vehicles**	**All with Services**	**No Services**
All	**18.9%** (4)	**21.3%** (11)	**18.8%** (11)	**24.6%** (11)*	**21.6%** (34)	**13.6%** (48)
Transit Availability						
High	35.3% (2)	24.4% (4)	27.2% (3)	33.5% (2)	28.8% (11)	23.6% (13)
Medium	14.1% (1)	25.6% (1)	12.6% (1)	15.0% (3)	21.0% (6)	8.0% (13)
Low	< 0 (1)	18.6% (6)	16.1% (7)	21.8% (6)*	15.5% (17)	11.1% (22)
Restricted Parking						
Yes	35.3% (2)	28.4% (6)	23.1% (5)	20.7% (5)*	27.9% (17)	20.3% (19)
No	2.6% (2)	12.8% (5)	15.2% (6)	17.2% (6)*	15.4% (17)	9.3% (29)
Parking Fees						
Yes	35.3% (2)	34.1% (5)	23.6% (4)	36.6% (5)*	31.4% (15)	18.2% (16)
No	2.6% (2)	10.7% (6)	16.1% (7)	14.6% (6)*	13.9% (19)	11.3% (32)
Level of Support						
High	n/a (0)	21.7% (6)	25.6% (5)	33.5% (6)*	26.5% (15)	12.4% (17)
Medium	15.8% (3)	12.8% (2)	12.9% (5)	14.0% (5)*	15.5% (14)	16.2% (19)
Low	28.2% (1)	26.3% (3)	14.1% (1)	n/a (0)	24.2% (5)	11.2% (12)
Modal Subsidies						
Yes	28.2% (3)	25.4% (9)	25.4% (7)	30.8% (8)*	26.7% (24)	14.7% (40)
No	0.0% (1)	13.4% (3)	7.3% (4)	8.3% (3)*	9.4% (10)	6.0% (8)
Telecommuting						
Yes	28.2% (1)	9.6% (2)	14.5% (3)	21.9% (4)*	18.3% (9)	14.6% (8)
No	15.8% (3)	23.9% (9)	20.4% (8)	26.2% (7)*	22.9% (25)	13.4% (40)
Compressed Work Week						
Yes	20.5% (3)	22.2% (3)	15.4% (2)	24.2% (7)*	23.0% (12)	16.2% (16)
No	14.1% (1)	21.0% (8)	19.5% (9)	25.4% (4)*	23.2% (22)	12.0% (32)

Note: Asterisked samples (*) include cases combined with other transportation services.

Sources: Derived from the Table 19-A sources (see Appendix A).

A surprisingly large number of employers (11) located in areas with high existing transit service availability are found to have engaged in providing transportation services. Examining the cases in this group, reasons seem to include:

1. The employer is very large, with a widely-scattered regional employment base, and either existing transit service doesn't extend far enough or cannot spread wide enough to serve employees.

2. The employer has felt, despite the generally good transit service, that it needed more capacity or more route coverage than the public transit agency is able to provide.

3. The employer has felt a particular kinship with some service, such as vanpools, for reasons unique to the organization.

Programs in this high transit availability category have an average VTR of 28.8 percent, which is quite high but still only 5.2 percentage points greater than those programs that had high transit availability but did not offer additional transportation services.

Restricted Parking. Sites where parking supply was restricted have higher overall VTR rates, and programs that provided transportation services in conjunction with restricted parking also perform better than those that do not. Sites with restricted parking that provided transportation services average a 27.9 percent VTR, which is 7.6 percentage points higher than comparable sites with restricted parking but no transportation services (20.3 percent VTR). Where parking was not restricted, programs offering transportation services outperform those without services by a similar margin, 6.1 percentage points, or 15.4 percent versus 9.3 percent. The overall effect of restricted parking as a condition corresponds with a greater difference in VTR than the difference related to transportation services. Having restricted parking averages about twice the impact of providing services. Nevertheless, there is clear evidence that providing services makes a significant difference.

Parking Fees. The influence of parking pricing is similar to that of restricted parking, only more so. The difference in VTR at sites with parking fees between programs that provided transportation services and those that did not is 31.4 percent versus 18.2 percent, or 13.2 percentage points. Meanwhile, for comparable programs where parking was not priced, those that provided transportation services average 13.9 percent VTR versus 11.3 percent for those without services, or only a 2.6 percentage point difference. Similarly, the difference between programs with transportation services that had parking fees versus those where parking was not priced is 17.5 percentage points, whereas programs that did not provide services have only a difference of 6.9 percentage points between situations were parking was priced versus not priced. Hence, not only do services make an important difference, the effect is accentuated when combined with parking fees.

Employer Support. Examining the relationships between transportation services and employer support programs yields somewhat inconclusive findings. Programs with transportation services at both high and low levels of employer support appear to perform quite well, both overall and in relation to programs at the same support level but without transportation services. Programs with services and high support average 26.5 percent VTR, or 14.1 percentage points higher than those without services (12.4 percent). Similarly, programs with low support but offering services average 24.2 percent VTR compared to 11.2 percent for those without services, a difference of 13 percentage points. This suggests that transportation services are very important in this relationship, and that the level of employer support seems to be relatively unimportant to the outcome if services are offered. This conclusion must be tempered, however, by the small sample size of 5 observations in the services/low support category and the curious result for programs with medium support. With medium support there is no major or logical difference between programs that offered transportation services and those that did not, and both cases are below the average 16.9 percent VTR for the sample. One thing that can be said is that the data in this table provide weak justification at best for expanded levels of employer support.

Modal Subsidies. The combining of modal subsidies with transportation services produces a set of outcomes that are similar to those with parking pricing. Transportation services programs which were paired with modal subsidies produce an average VTR of 26.7 percent, compared to only 9.4 percent for those without modal subsidies, a difference of 17.3 percentage points. This compares to a difference of only 8.7 percentage points between situations where modal subsidies were or were not provided within programs not including transportation services (14.7 percent versus 6.0 percent VTR). Also noteworthy is that programs that provided modal subsidies exhibit a much bigger difference in VTR performance with versus without transportation services—26.7 percent against 14.7 percent, or a 12.0 percentage point difference—than when no subsidies were offered, namely 9.4 percent with transportation services versus 6.0 percent without, or only a 3.4 percentage point difference. The synergy between transportation services and modal subsidies is both obvious and strong.

Telecommuting. An inference that can be drawn from the VTR comparisons in Table 19-4 is that work hours strategies like telecommuting may conflict with the modal shift objectives of transportation services. Where telecommuting was offered along with transportation services, the result is a VTR which—when computed on the basis of mode shifts alone—is 4.6 percentage points lower than when telecommuting is not provided. It may be that when employees are released from the expectation of traveling to the worksite each day, it becomes harder to conform to the schedule discipline of using an alternative mode, particularly ridesharing.

Despite that possible effect, the presence of a telecommuting program may still reduce overall vehicle trip making through its elimination of physical commute trips in an amount equal to the average number of days per week that the telecommuting individuals do not go to their employment site. TDM regulatory programs typically provide credit for these reductions in their trip generation formulas, which account for total trips by mode over a 5-day cycle. Unfortunately, data from the 82-program sample drawn upon here is insufficient to calculate a trip generation reduction for telecommuting, since neither the percentage of employees who telecommuted nor the number of days per week they did so is known.[7]

The only positive observation that can be made given data limitations is that even with the possibly adverse mode choice effects of telecommuting, programs that offered transportation services appear to perform better than those without services. It is also important to point out that overall evidence on the mode choice effects of telecommuting is mixed, as suggested by the examples provided under "Response to Alternative Work Arrangements"—"Additional Research Evidence on Alternative Work Arrangements"—"Telecommuting."

Compressed Work Weeks. A slightly less ambiguous result is produced in combination with CWW, another alternative work hours strategy, even though the same 82-program sample data limitations apply. Programs offering transportation services perform just about the same in terms of mode shifts with or without the presence of CWW (about 23 percent VTR computed on the basis of mode shifts alone). This would suggest that, in the presence of transportation services, the gain

[7] For additional discussion of this limitation in the 82-program sample, and its implications, see the final paragraph of the "Analytical Considerations" subsection in the "Overview and Summary."

in trip reduction that comes from fewer work days is not cancelled out by mode shifts. As with telecommuting, CWW programs that offered transportation services have higher VTRs than those not providing services. It does not appear, however, that transportation services and CWW have a synergistic relationship.

Additional Evidence of Transportation Services Effects

Employer-Assisted Transit Service. Two types of employer intervention with transit service are observed. One is supplementing existing fixed-route bus service with additional service or routes, and the other is operation of shuttle services to either connect with regional rail transit service or to provide midday circulation.

Table 19-5 lists a number of employers from the 82-program sample that achieved fairly substantial vehicle trip reductions in conjunction with providing one or more transportation services. Of course, there are many other aspects of these particular exemplary programs that may have led to their performance, such as parking conditions, financial incentives, and employer support, and these characteristics are also summarized in the table. This presentation is provided to offer some insight as to what elements may contribute to the success of these service-oriented programs.

The "Type of Services" column of Table 19-5, as the heading suggests, indicates the type of transportation service offered by each particular employer or institution at the time the information was compiled. The first two examples, Puget Sound Blood Center and Swedish Hospital, are neighboring medical establishments in Seattle's First Hill area. This area, which lies on the fringe of the CBD, has above-average transit service. However, these employers took steps to coordinate with each other and the transit operator, Metro, to bring more service to the area. Parking in the area is limited, which affects access not only by employees but also by patients and visitors. The increased transit service was matched by employee transit subsidies and other financial incentives as part of the arrangement with Metro to ensure ridership. The results were vehicle trip rates of 42.4 percent and 28.2 percent, respectively, below the average for the surrounding area, indicating very effective vehicle trip reductions.

P. L. Porter and Pacific Bell had programs that focused mainly on vanpooling, but also provided transit or van shuttle service to distant rail transit stations. Even though they are in remote locations with free parking, the combination of the transportation services with subsidies resulted in vehicle trip rates of 0.67 and 0.73, which are 23 percent and 21.5 percent lower, respectively, than their adjacent areas.

Table 19-5 Exemplary Employer Transportation Services Programs

Employer	Type	Size	Setting	Transit Availability	Support Level	Type of Services[a]	Parking[b]	Financial Incentives[c]	VTR[d]
Puget Sound Blood Center	Medical	200	CBD Fringe	High	Medium	TR	R, P, D	T, O	42.4%
Swedish Hospital	Medical	2,250	CBD Fringe	High	Low	TR	R, P, D	T, A	28.2%
Univ. of Washington	University	17,400	CBD Fringe	High	High	TR, VP	R, P, D	T	62.0%[e]
Sears (Hoffman Estates)	Comm./Svc.	5,400	Exurban	Low	High	TR, VP		T	42.4%
P.L. Porter	Ind./Manuf.	230	Campus	Low	Medium	TR, VP		T, V	23.0%
Pacific Bell (San Ramon)	Utility	6,900	Exurban	Low	High	TR, VP	R		21.5%
So. California Gas	Utility	1,800	Exurban	Low	High	VP, CV	R, P, D	T, A	47.4%
Travelers Insurance	Prof./Office	10,000	CBD	High	Low	VP	R, P, D	T, V	42.4%
Atlantic Richfield	Prof./Office	2,000	CBD	High	High	VP	R, P, D	V, A	34.5%
Bonneville Power	Utility	100	CBD Fringe	Medium	Medium	VP	R, P, D	T	25.6%
Rockbestos	Ind./Manuf.	400	Exurban	Low	Low	VP			29.0%
Johnson & Higgins	Prof./Office	180	CBD	High	High	CV	R, P	T	44.2%
City of Simi Valley, CA	Gov't.	150	Suburban	Low	High	CV		T, A, O	43.5%
CH2M Hill (Bellevue)	Prof./Office	400	Sub CBD	Medium	Medium	CV	R, P, D	T, C, A	38.9%
Bellevue City Hall	Gov't.	650	Office Park	Medium	Medium	CV	R, P, D	T, V, A	30.0%
Wm. H. Mercer	Prof./Office	120	CBD	High	High	CV	P, D	T	22.7%

Notes: [a] Codes: TR = Transit, VP = Vanpool, CV = Company Vehicles.

[b] Codes: R = Restricted, P = Priced, D = HOV Discounts.

[c] Codes: T= Transit Subsidy, V = Vanpool Subsidy, C = Carpool Subsidy, A = Travel Allowance, O = Other Monetary.

[d] VTR = vehicle trip reduction, defined as the percentage by which the vehicle trip rate (vehicle round trips per 100 employees commuting) for the program is less than the vehicle trip rate for the control population.

[e] See accompanying text and also case study "University of Washington's U-PASS Program — Seattle, Washington" Footnote 21.

Sources: Derived (see Appendix Table 19-A) from Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

Sears, upon relocation of its headquarters operations to Hoffman Estates in the outskirts of Chicago, arranged for contract transit service for its employees, many of whom realized long commutes. Subsidy was paid through the employees to the transit provider. In conjunction with its vanpool program, Sears achieved a vehicle trip rate of only 0.53, 42.4 percent lower than the average for the surrounding area. The Sears example is somewhat of a special case, given the relocation involved, though a similar situation applies to the Pacific Bell example as well. (Further background on the Sears Hoffman Estates program is found in the case study, "Pace Vanpool and Subscription Bus Programs in Suburban Chicago," in Chapter 5, "Vanpools and Buspools.")

The University of Washington, involving students as well as faculty and staff, also presents a special case. Located on a campus that is somewhat removed from downtown Seattle, it made arrangements with transit operator Metro to provide up to 6,000 hours of additional service to the campus per year. To support this commitment of service, the University has carefully managed its parking supply and prices, and in addition has offered attractive subsidies to students and staff through Metro's U-PASS program. The result is a vehicle trip rate on the order of 0.27 to 0.29 per person for the campus. This rate has been calculated as being 62 percent lower than the surrounding area (Comsis, 1994), or 31 percent lower than the before-program University rate. The University of Washington program is covered further in the case study, "University of Washington's U-PASS Program—Seattle, Washington" (see "Case Studies" section including Footnote 21).

Shuttles and Circulators. Although they are not purely employer-provided transit services, there are many examples where cooperative efforts have been made to institute shuttle services to either close a gap in existing service, formalize a connection with regional transit, or improve internal circulation and thus reduce auto dependency. Table 19-6 lists ten such services that were staged as demonstration projects under the Los Angeles County Metropolitan Transportation Authority's regional TDM program.

This group of examples is selected for presentation because of special evaluation data that were obtained for the projects, permitting assessment of the services' impact on diverting SOV trips and subsequent claimed vehicle trip reduction. The table also shows annual cost for the service and the resulting cost per VTR as a measure of effectiveness. (No information on the physical magnitude of the services is available.) Daily ridership on these services ranged from 11 to 239 riders and costs ranged from $5.15 to $75.60 per VTR. Perhaps what is most interesting about these services is the degree of prior SOV use for the commute, ranging from a low of 33 percent prior SOV mode share among users up to 75 percent or more. One-half of all the cases are in the over-75-percent category. Data are insufficient to ascertain how frequently the former SOV users actually used the shuttle, or the extent to which the feeder service or the internal circulation element is most critical to the modal shift (Comsis and Pansing, 1997).

Employer-Assisted Vanpool Service. There are numerous ways that employers can get involved in providing a vanpool option for their employees. Perhaps the simplest is offering a subsidy, although the evidence from the 82-program sample is that, by itself, that approach is not particularly effective (as discussed in the "Response to Incentives and Disincentives" subsection below). What does seem to have more impact is when employers get materially involved in the facilitation and administration of a vanpool program, relieving employees of major logistical burdens.

Table 19-6 Effectiveness of Transit Shuttle Services Tested as Demonstration Projects in the Los Angeles Area

Service/Description	Daily Shuttle Use	Prior SOV Use[a]	Annual VTR[b]	Annual VMTR[c]	Annual Cost	Cost per VTR
<u>**All-Day Shuttles**</u>						
Children's Court Shuttle: Employee and visitor shuttle between rail station and court complex	239	33%	16,760	835,380	$333,524	$19.90
PVTA Metrolink Shuttle: Subscription service for commuters to Pomona/Claremont stations preferential parking	21	76%	3,840	23,040	$48,691	$12.68
<u>**Mid-Day Shuttles**</u>						
Santa Clarita Shuttles and Shelters: City-implemented mid-day circulator between industrial park and town center	11	77%	1,984	15,872	$56,822	$28.64
West Hollywood Sunset Shuttle: TMA-supported shuttle service along Sunset Blvd.	70	51%	6,250	9,950	$275,625	$44.10
<u>**Peak Period Shuttles**</u>						
Hollywood Connection: Feeder service for employees linking with bus and Metrolink	90	76%	66	1,970	$84,542	$5.15
Burbank Media District Shuttle: TMA-provided service between Burbank Media District and Metrolink	165	78%	30,888	617,760	$193,050	$6.25
12th Council District Taxi Voucher: Free taxi feeder between Metro and employment sites	73	55%	19,200	364,800	$138,040	$7.19
Lincoln Corridor Shuttle: Commuter service between Pacific Palisades and El Segundo	40	66%	6,256	67,220	$259,249	$41.44
Burbank Flat Fare Taxi: Home-work taxi service for Media District employees	34	78%	6,365	19,094	$88,155	$13.85
Westside RUSH: 5 TMA-sponsored shuttles to fill gaps in existing service	84	46%	9,246	36,523	$698,998	$75.60

Notes: [a] Percentage of users reporting their prior commute mode as single occupant vehicle (SOV).

[b] Vehicle Trips Reduced (round trips).

[c] Vehicle Miles of Travel Reduced.

Source: Comsis and Pansing (1997).

Effective vanpool involvement includes taking the lead in procuring vehicles, either through lease or purchase; underwriting a service arrangement with a vanpool provider; offering use of company vans for use by vanpool units; providing or cost sharing in van maintenance, fueling, or insurance; and, perhaps most importantly, being a strong advocate for the program. The strong vanpool system performers in Table 19-5 are all marked by solid corporate/institutional backing of the vanpool program. Organizational leadership views the program as an important benefit for employees, a demonstration of their loyalty, and not coincidentally, a means for acquiring and retaining employees, particularly when the site is remotely located and travel there is viewed as a burden.

In the case of Sears and Pacific Bell, the vanpool program was an important element facilitating relocation of large operations from an urban site to a remote exurban area. The sense is that the vanpool and related programs were key to the viability of the move. At the other extreme are employers like Atlantic Richfield Company in downtown Los Angeles or Travelers Insurance in downtown Hartford that opted for vanpool programs in spite of locations near good public transit service. They may have concluded that including a vanpool alternative was the only way to fully serve all of their employees.

It should be noted that not all successful vanpool programs are limited to large employers. The programs of P. L. Porter (230 employees), Bonneville Power (100 employees), and Rockbestos (400 employees) are examples of modest size employers that have been very effective with a well-executed vanpool effort. Nor are vanpool programs necessarily limited to commute populations with long trip lengths, although longer trips are usually the primary market.

The vanpool chapter in the 1993 Federal Highway Administration report on *Implementing Effective Travel Demand Management Measures* describes an interesting program at the Aerospace Corporation in Los Angeles where vanpools were used to serve a variety of employee travel markets. As of 1990, 15 percent of Aerospace's employees were using vanpools (another 19 percent used carpools), thanks to attractive pricing and treatment. The company enabled lower fares by 12-year amortization of vehicles, and maintenance was performed by the company. Preferential parking was a meaningful perk given the large size of the workforce (6,000 employees). But perhaps most interesting is that 13 of the 60 vanpools had average trip lengths in the 10 to 20 mile range, which is fairly short for vanpools. Vanpooling was motivated by the company's extensive support as well as the fact that many of the employees lived in clusters across the region, enabling easy assembly of travel groups (Comsis and ITE, 1993). *TCRP Report 95,* Chapter 5, "Vanpools and Buspools," provides additional information on this service.

Use of Company Vehicles. An increasing number of employers are offering company fleet vehicles to employees as an inducement to use alternative modes for commuting. In most instances the company vehicles are made available for midday business trips. This was the case with Johnson & Higgins, City of Simi Valley, CH2M Hill, Southern California Gas, and Wm. H. Mercer, in Table 19-5. The City of Bellevue, Washington, at the time offered a slightly different twist—allowing employee groups of three or more to use the vehicles for commuting (a practice since discontinued). Each of these listed sites achieved a notable vehicle trip reduction, although it would appear that parking conditions, transit availability, and financial incentives also played a significant role in each program's performance. Nevertheless, providing for the employee's travel needs once at the work site, particularly in pedestrian-unfriendly areas like office parks or suburban strip developments, can alleviate a major impediment to the decision to forego having one's car at the workplace.

Car Sharing. An alternative to offering use of company or fleet vehicles involves utilizing quickly executed short-term vehicle rentals from a private vendor, known as car-sharing. Registered users reserve a car online or by phone, walk to a conveniently located available vehicle, and access it with an electronic key card. The user is subsequently billed for all transactions. An introduction to car sharing is provided in Chapter 14, "Road Value Pricing," under "Response by Type of Strategy"—"Response to Vehicle Use Pricing Systems."

The concept has been popular for some time outside the United States as a residential-based service, particularly in urban areas where car ownership is difficult. Increasingly, however, employers are finding value in car-sharing to help address employee transportation issues, including not only mobility for midday business travel, but as a means to reduce parking demand and traffic associated with employee vehicle use. *TCRP Report 108,* "Car-Sharing: Where and How It Succeeds," presents examples of employers in the Seattle, Washington, CBD and CBD fringe area who have successfully incorporated car-sharing strategies into their TDM programs (Nelson\Nygaard and Westat, 2005):

- The Seattle Times has used car-sharing to reduce parking demand following sale of several of its surface parking lots. Of employees surveyed in advance of the program, 15 percent stated that access to a car during the day would help them not to drive to work.

- Swedish Medical Center has employed car-sharing as a commute trip reduction strategy and as a way to provide transportation between its six campuses. Staff calculated that car-sharing was cheaper than either a shuttle or paying parking and mileage expenses. Swedish allows all employees access to car-sharing for business purposes, and also allows personal use by those who have not obtained a parking permit.

- The Defender Association used car-sharing to eliminate one-half of its 20 parking spaces, thereby qualifying it for a Metro transit incentive, FlexPass. This allowed it to absorb the cost of continuing to provide transit passes to its employees while also applying savings to costs of the FlexCar car-sharing service (Nelson\Nygaard and Westat, 2005).

Transportation Management Associations (TMAs) may have the potential to become brokers in the use of car-sharing services by providing memberships for employers and integrating those programs with transit and other TDM strategies. Portland's Lloyd District TMA built on its "PASSport" employer transit pass to fund the PASSport+ program, which allows unlimited use of FlexCar vehicles in the TMA district during business hours for PASSport holders who sign up for car-sharing (Urban Transportation Monitor, 2002).

Back-to-back car-sharing demonstration projects conducted in the San Francisco Bay area between 2001 and 2003, branded CarLink, provide more travel behavior change information and additional support for the potential of this strategy. In CarLink I (January–November 1999), 54 individuals from San Francisco, Oakland, and the East Bay enrolled in a program involving 12 compact rental cars. The vehicles were based in premium parking spaces at the Dublin-Pleasanton BART station and, except for accommodating 10 home-based "traditional" commuters, were set up to serve travel needs of employees at the Lawrence Livermore National Laboratory. Three separate user groups were involved: home-based users commuting to the BART station, work-based commuters reverse-commuting to Lawrence Livermore via the BART station, and shared vehicle day users at the worksite. Each group paid a distinct fee according to duration of car use, with fees including fuel, insurance and maintenance costs. Travel behavior analysis for CarLink I showed an increase in rail transit (BART) mode share of 23 percent, a reduction in drive-alone mode share of 44 percent, and a decrease in average daily vehicle miles of travel (VMT) of 18 miles (Shaheen and Rodier, 2005).

CarLink II was a more expansive test, involving 19 cars and 107 participants, and running for 12 months (July 2001–June 2002). The experiment was located in Palo Alto in conjunction with Caltrain commuter rail service and the employment base of Stanford Research Park (150 research and technology companies and 23,000 employees). Workplace involvement was, however, limited to 6 employers. Again, three distinct categories of users shared the CarLink vehicles:

1. Home-based users, who lived in or near Palo Alto, and for a fee of $300 a month were able to drive a CarLink vehicle to the Caltrain California Avenue station each weekday morning before taking a train to work and then home again at night, while also having access to the vehicles on evenings and weekends.

2. Work-based commuters, who were employees at Stanford Research Park and, for a fee of $50/month, used the vehicles parked at the California Avenue station to shuttle between Caltrain and the worksite.

3. Work-based day users, employees of the participating employers at Stanford Research Park, who were able to use the vehicles for personal and business trips during the day under a subscription package to employers of $300/month per vehicle.

Table 19-7 shows what appear to be rather impressive results from the CarLink II experiment. Using before-and-after surveys along with 3-day travel diaries, the researchers determined a fairly significant decline in driving alone as a commute mode. SOV use for all or part of the home-to-work commute dropped from 37.5 percent to 12.5 percent for the home-based users, and from 64.1 percent to 41.2 percent for the work-based commuters and day users. Correspondingly, use of Caltrain—obviously as the primary commute mode—increased from 56.3 percent to 100 percent for the home-based group and from 35.9 percent to 56.9 percent for the work-based group. At the same time, however, rates of carpooling and bicycling dropped for both groups, and use of bus/shuttle declined for the work-based group, reflecting the greater convenience of CarLink. Also, many participants still used personal vehicles to access transit on their non-CarLink terminus.

The VMT results for CarLink II showed that VMT for round-trip commuters was reduced by 23 miles per day as members shifted to Caltrain. The VMT reduction was entirely produced, however, by the work-based commuters/employees, as detailed in Table 19-7. Meanwhile, travel times increased by an average of 31.5 minutes per day, while commuter stress reportedly decreased. Almost 6 percent of program participants sold or stored a personal vehicle, while none leased or purchased a personal vehicle (Shaheen and Rodier, 2005).

Table 19-7 Before and After Commute Mode Shares and VMT for CarLink II Participants

	Mode Shares and VMT Before			Mode Shares and VMT After			Change in Mode Share (Percentage Points) and Change in VMT		
Modes	**HB**[a] (n = 15)	**WB**[b] (n = 92)	**All** (n = 107)	**HB** (n = 8)	**WB** (n = 51)	**All** (n = 59)	**HB**	**WB**	**All**
Drive Alone	37.5%	64.1%	60.2%	12.5%	41.2%	37.3%	-25.0%	-22.9%	-22.9%
Carpool	12.5	10.9	11.1	0.0	11.8	10.2	-12.5	0.9	-0.9
Bus/Shuttle	25.1	22.8	23.2	37.5	13.7	15.3	12.4	-9.1	-7.9
Caltrain	56.3	35.9	39.6	100.0	56.9	62.7	43.7	21.0	23.1
Bike	12.5	5.4	6.5	0.0	3.9	3.4	-12.5	-1.5	-3.1
Walk	43.8	22.8	25.9	50.0	52.9	52.5	6.2	30.1	26.6
Other	6.3	2.2	3.7	12.5	11.8	11.9	6.2	9.6	8.2
CarLink	0.0	0.0	0.0	100.0	56.9	62.7	100.0	56.9	62.7
VMT[c]	10.4	34.4	30.8	11.6	7.2	7.8	1.2	-27.2	-23.0

Notes: Unlike most presentations of mode share data, this tabulation treats each component mode of a multi-mode trip separately. Thus a trip from work to home via CarLink, Caltrain, and walking is entered into the tabulation as one CarLink trip, one Caltrain trip, and one walk trip. Since many participants already took more than one mode to commute, the total percentages of mode use sum to more than 100 percent both before and after CarLink.

[a] HB = Homebased Users.

[b] WB = Workbased Commuters and Day Users.

[c] Total Drive Alone, Carpool, and CarLink VMT.

Source: Shaheen and Rodier (2005).

An important factor that cannot be tested in a limited-scale pilot program such as this is the market penetration a full-scale program could achieve. The market for the home-based users and the work-based commuters in a transit-linked program like CarLink II would be limited by the extent of the transit service residential and employment commutersheds involved and the proportions and quantities of daily commutes actually oriented to the transit line. The market would also be limited by the degree of employer interest, an aspect of TDM effectiveness examined in the "Voluntary Versus Regulatory Employer Motivation" subsection of the "Underlying Traveler Response Factors" section. Finally, it should be noted that all reports encountered of workplace-based car-sharing successes come from areas where transit service is quite strong.

Transportation Brokerage. For lack of a better term, there are occasions when either an area-wide organization or a large employer takes on the role of transportation broker, in which it attempts to provide for the transportation needs of commuters in an environment where alternatives to driving are very limited. Historical examples of employers adopting this approach include the 3M Corporation in the Twin Cities and CONOCO in Houston (Pratt and Copple, 1981; Enoch and Zhang, 2008).

A classic example is that of the Tennessee Valley Authority (TVA) in Knoxville, where extensive involvement by the TVA in the 1970s led to large increases in ridesharing among employees. The TVA program was oriented almost exclusively toward its approximately 3,000 central headquarters employees in downtown Knoxville. The program grew from one express bus in late 1973 to 10 buses carrying 330 people and six vanpools carrying 69 people 1 year later. Support actions included worksite advertising, a (pre-internet) telephone information service, carpool matching, and vehicle leasing assistance. Not insignificantly, a national fuel crisis occurred that year, with gasoline price increases that obviously raised interest in alternatives to driving. The program continued, however, long after the initial shock. Bus and vanpool subsidies were added, as were preferential, inexpensive carpool parking spaces. By the end of 1976, 23 express buses, 18 vanpools, and 436 carpools were carrying 950, 2,400, and 1,400 employees, respectively, while site employment had grown by 400. The dramatic mode shifts and parking demand reductions that occurred are shown in Table 19-8 below for pre-program, program without monetary incentives, and program with monetary incentives (Wegmann, Chatterjee, and Stokey, 1979):

Table 19-8 Impacts on Mode Share of the TVA Transportation Brokerage Program

Mode and Other Information	Before Program	After Program (Context and Implementation Stages)			
		First Stage Gasoline Crisis Effect	Stage 1: Before Monetary Incentive	Second Stage Gasoline Crisis Effect	Stage 2: After Monetary Incentive
Drive Alone	65%	Yes	42%	No	18%
Carpool	30	Yes	40	No	41
Vanpool	0	Yes	2	No	7
Express Bus	0	Yes	11	No	28
Regular Bus	3	Yes	3	No	3
Other	2	Yes	2	No	3
Employment	2,950	—	3,000	—	3,400
Parking Demand	2,200	—	1,940	—	1,070

Source: Wegmann, Chatterjee, and Stokey (1979) with elaboration.

The success of the TVA project spawned a citywide "brokerage" program in January 1976. By June 1977, 47 vanpools were carrying 450 commuters to 12 employers. Over 18,000 people had requested and received carpool match lists. A random sample indicated that 13 percent of the lists were used to make initial contacts with the intent of ridesharing. However, only 3.3 percent of those using the lists (approximately 80 persons) actually entered into ridesharing agreements. Degree of response was said to relate to the level of employer interest at each firm contacted (U.S. Department of Energy, 1979).

Response to Incentives and Disincentives

The theoretical basis for the role of incentives and disincentives in encouraging use of alternative modes is examined in the "Individual Behavioral and Awareness Considerations" subsection of the "Underlying Traveler Response Factors" section. In summary, to make alternative modes more attractive, it is frequently necessary to provide incentives to reduce the competitive advantage driving often provides in terms of door-to-door time savings and convenience. These incentives may act to reduce either the travel time or the travel cost associated with using the alternative, such that the comparative disadvantage vis-à-vis auto use is reduced or reversed. Both travel time and cost incentives are relevant in the choice of commute mode. Ways to improve the comparative travel time of alternative modes include:

- Reducing over-the-road travel time by providing HOV lanes on highways or streets, or providing exclusive access via HOV ramps or turning provisions.

- Reducing wait or walk time in the case of transit, by shortening headways between transit vehicles, reducing the number or duration of transfers, or enhancing route coverage.

- Providing exclusive, close-in parking at the work site for carpool or vanpool users, thus offering a walk time advantage over those driving alone.

With exception of the third strategy, preferential parking, which was discussed earlier as a support strategy, these travel time strategies are not the subject of this chapter. Over-the-road travel time savings and reductions in transit wait or access time are public-side strategies (neither employer-provided nor TDM per se), and are discussed in detail in Chapters 2 and 3, "HOV Facilities" and "Park-and-Ride/Pool"; Chapters 4 through 8, which as a group cover "Transit Facilities and Services"; and Chapters 9 through 11, which address "Public Transit Operations."

The economic incentives covered in this chapter and this section are financial incentives. In other words, they involve actions that either transfer money to decrease the cost of using alternative modes, increase the cost of driving alone (disincentives), or otherwise provide a benefit which has monetary value to those who would use alternative modes. These include:

- Alternative mode subsidies (incentives).

- Parking fees or surcharges (disincentives).

- HOV parking discounts for carpools or vanpools (incentives).

- Travel allowances (also includes parking "cash-out"), which allow the recipient to make the best travel choice given a discretionary budget, perhaps in lieu of free parking (normally functioning as incentives).

- Various gifts, drawings, prizes, or privileges that have a tangible monetary value (incentives).

In this discussion, "incentives" will generally be used as shorthand for both incentives and disincentives.

Incentives Insights from the 82-Program Sample

Table 19-9 cross-classifies incentives used by the employers in the 82-program sample and presents the VTRs associated with each cross-classification and with each incentive category overall (the "All With Incentive" row). The sample data in the cross-tabulation frame a picture of the frequency with which particular incentives were used within the sample, alone or in combination. The VTR percentages illuminate their relative associations with apparent employee vehicle trip reductions.

Note that restricted parking is included in this table, not because it is considered a financial incentive, but for the purpose of conditioning its importance in relation to other incentives.

Individual Incentives. Focusing first on the bottom two rows of Table 19-9, it is possible to review the separate occurrence rate and impact differential for each incentive. Clearly the biggest differential among the incentives shown is with parking pricing: The 31 programs that employed parking fees have an average VTR of 24.6 percent, which is double the 12.3 percent VTR for those sites with free parking.

Of similar magnitude, in comparison with unpriced parking, is the effect of providing parking discounts for HOVs as part of parking pricing. Obviously, parking must first be priced in order for the discounts to be relevant, hence 22 of the 31 programs with parking fees also offered discounts for HOVs. These 22 programs exhibit an average VTR of 25.7 percent, which is 1.1 percentage points above the VTR for all 31 sites with parking fees and 13.4 percentage points greater than for the 51 sites with no parking pricing or discounts at all.

Transit fare subsidies were the most commonly offered incentive, seen in over one-half of the examples. Programs with transit subsidies have the third largest impact in terms of VTR, with such programs exhibiting an average VTR of 20.6 percent, 7.5 percentage points higher than the 13.1 percent VTR in those programs not offering transit fare subsidies.

The VTRs associated with vanpool subsidies in Table 19-9 suggest a curious inverse relationship, wherein programs that offered subsidies show up as less effective than those that did not (15.3 percent VTR versus 17.2 percent VTR). A deeper analysis of this finding—beyond that available in the table—reveals that of the 12 programs providing vanpool subsidies, six operated a vanpool program as a transportation service and six did not. The six with a vanpool service have an average implied VTR of 20.9 percent. The other six, which had a vanpool subsidy but not a vanpool service, average a VTR of only 9.8 percent. Hence, the effectiveness of the vanpool subsidy is more than doubled when combined with a formal vanpool service.

Also relevant are the results for 16 employers who provided a vanpool transportation service but did not offer a separate and distinct vanpool subsidy. These sites had an average VTR of 19.8 percent, almost as high as programs that reported both a vanpool service and a vanpool subsidy. This dissection of the data suggests that vanpool service provision may be much more important than a separate subsidy. It may also be that the employer vanpool service programs contained one or more implicit subsidies. In any case, it is the inclusion of relatively more programs without vanpool operations in the Table 19-9 aggregation of employers offering vanpool subsidies that drags down the average VTR, not any inherent flaw in subsidization of HOV use.

Table 19-9 Vehicle Trip Reduction Percentages Related to Monetary Incentives

	VTR by Type of Employer Incentive Offered (Sample Size)								
Other Incentive	**Parking Fees**	**HOV Discounts**	**Transit Subsidy**	**Vanpool Subsidy**	**Carpool Subsidy**	**Bike/Walk Subsidy**	**Travel Allowance**	**Other Monetary**	**All**
Restricted Parking	27.6% (26)	29.8% (18)	27.8% (23)	36.2% (3)	26.6% (3)	30.4% (1)	22.8% (12)	29.9% (2)	24.6% (35)
Parking Fees		25.8% (21)	27.6% (21)	36.2% (3)	24.7% (2)	n/a (0)	23.8% (12)	29.0% (2)	24.6% (31)
HOV Parking Discounts			26.9% (16)	36.2% (3)	38.9% (1)	n/a (0)	28.9% (8)	29.0% (2)	25.7% (22)
Transit Subsidy				14.4% (10)	20.5% (3)	12.1% (2)	26.2% (8)	22.5% (6)	20.6% (42)
Vanpool Subsidy					12.1% (1)	12.1% (1)	23.4% (3)	9.7% (2)	15.3% (12)
Carpool Subsidy						21.3% (2)	24.7% (2)	n/a (0)	23.0% (4)
Bike/Walk Subsidy							n/a (0)	12.1% (1)	18.2% (3)
Travel Allowance								26.2% (4)	19.3% (24)
Other Monetary									23.1% (11)
All with Incentive	24.6% (31)	25.7% (22)	20.6% (42)	15.3% (12)	23.0% (4)	18.2% (3)	19.3% (24)	23.1% (11)	
All without Incentive	12.3% (51)	13.8% (60)	13.1% (40)	17.2% (70)	16.6% (78)	16.9% (79)	16.0% (58)	16.1% (71)	

Note: Restricted parking is not a monetary incentive per se, but is included for comparison.

Sources: Derived (see Appendix Table 19-A) from Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

Table 19-9 shows that carpool and bike/walk subsidies were fairly uncommon, found at only four and three sites, respectively, although they are associated with above-average rates of VTR in the particular cases involved. The travel allowance and other monetary incentives are associated with above-average rates of VTR, while the comparable employers without those incentives have below-average VTRs. In these examples, the travel allowance only accounts for a 3.3 percentage point difference compared to programs not offering it, while the other monetary category accounts for a 7.0 percentage point difference.

Incentive Combinations. The top portion of Table 19-9 illustrates VTR performance for incentive combinations found in the 82-program sample. There are many cases where the combined occurrence of an incentive pairing is sufficiently uncommon that it shows a small sample size (three or less), and hence its average VTR performance must be treated with special caution. What seem to be the most frequent incentive combinations and their effective impacts follow:

- Parking fees (priced parking) together with restricted parking averages 27.6 percent VTR, while restricted parking overall and priced parking overall both average 24.6 percent.

- Parking fees with HOV parking discounts averages 25.8 percent VTR, slightly greater than parking pricing overall (24.6 percent).

- Programs including a transit fare subsidy (20.6 percent average VTR) have a lower VTR average when combined with subsidies for competing modes, such as vanpool subsidies (14.4 percent) and bike/walk subsidies (12.1 percent). There is no clear explanation for this except possibly the small sample sizes (two to three programs) when in combination with carpool and bike/walk subsidies. In any case, the VTR is virtually undiminished when combined with carpool subsidy (20.5 percent), and is enhanced when combined with the travel allowance (26.2 percent) and other monetary incentives (22.5 percent).

- The travel allowance does better than its average program VTR of 19.3 percent in all combinations with other incentives, including transit (26.2 percent), vanpool (23.4 percent), and carpool subsidies (24.7 percent), and also works better with parking fees (23.8 percent) or restricted parking (22.8 percent).

- Other monetary incentives (23.1 percent) appear to be enhanced when teamed with restricted parking (29.9 percent), parking fees (29.0 percent), HOV parking discounts (29.0 percent) and travel allowance (26.2 percent), but show less impact when teamed with transit (22.5 percent), vanpool (9.7 percent), or bike/walk subsidies (12.1 percent).

One is tempted to wonder if the relatively poor VTR showing for several modal subsidy combinations is a reflection of lack of program focus. There is, unfortunately, no data to either support or reject such speculation. Small program sample sizes in the case of several combinations together with the inherent variability among program circumstances remain more obvious potential explanations.

Effects Without Restricted or Priced Parking. It is generally acknowledged that parking conditions at a work site have a major underlying effect on the success of TDM programs. Where parking supply is limited or restricted (Chapter 18, "Parking Management and Supply") or where it is not free (Chapter 13, "Parking Pricing and Fees"), the desire of employees to find and use alternatives is demonstrably more urgent. To test this effect in the analysis of incentive measures, Table 19-10 summarizes the performance of those 27 programs that offered incentives but had no restrictions on parking. As a group, these 27 programs have an average VTR of 14.3 percent, which is less than the overall average for the 82-program sample of 16.9 percent. In addition, in a direct cell-by-cell comparison of Table 19-10 with Table 19-9, the combinations without restricted or priced parking exhibit a lower VTR in each case with data available where the included examples are not identical.

On the other hand, the 14.3 percent overall average VTR for the 27 programs without restricted/priced parking is greater than the average VTR of 7.0 percent for the 14 programs that had unrestricted parking and also did not offer subsidies. The four employers in the 82-program sample who had restricted/priced parking but did not offer subsidies have an average VTR of only 11.5 percent. The 37 employers who had both restricted/priced parking and offered subsidies have an average 23.3 percent VTR.

Table 19-10 Vehicle Trip Reduction Percentages Related to Monetary Incentives in the Case of Programs Without Restricted or Priced Parking

	VTR by Type of Employer Incentive Offered (Sample Size)					
Other Incentive	**Vanpool Subsidy**	**Carpool Subsidy**	**Bike/Walk Subsidy**	**Travel Allowance**	**Other Monetary**	**All**
Transit Subsidy	8.7% (8)	12.1% (1)	12.1% (2)	18.3% (3)	18.5% (5)	13.5% (21)
Vanpool Subsidy		12.1% (1)	12.1% (1)	5.6% (1)	9.7% (2)	8.4% (9)
Carpool Subsidy			21.3% (2)	n/a (0)	n/a (0)	21.3% (2)
Bike/Walk Subsidy				n/a (0)	12.1% (1)	18.2% (3)
Travel Allowance					26.2% (4)	14.8% (12)
Other Monetary						21.7% (9)

Note: Overall average VTR is 14.3 percent for these 27 programs without restricted or priced parking. See text for other aggregations.

Sources: Derived (see Appendix Table 19-A) from Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

Incentives in Conjunction with Other Site Conditions or TDM Strategies

Table 19-11 provides an assessment of how the various incentive strategies influence or are aided by other site conditions or TDM strategies. Once again, the 82-program sample is drawn upon.

Table 19-11 Vehicle Trip Reduction Percentages Related to Monetary Incentives and Other Site Programs or Conditions

	VTR by Type of Incentive Offered (Sample Size)																
	Parking Pricing		**HOV Discounts**		**Transit Subsidy**		**Vanpool Subsidy**		**Carpool Subsidy**		**Bike/Walk Subsidy**		**Travel Allowance**		**Other Monetary**		
Other Conditions	**With**	**W/out**	**With**	**W/out**	**With**	**W/out**	**With**	**W/out**	**With**	**W/out**	**With**	**W/out**	**With**	**W/out**	**With**	**W/out**	**All**
All	**24.6%** (31)	**12.3%** (51)	**25.7%** (22)	**13.8%** (60)	**20.6%** (42)	**13.1%** (40)	**15.3%** (12)	**17.2%** (70)	**23.0%** (4)	**16.6%** (78)	**18.2%** (3)	**16.9%** (79)	**19.3%** (24)	**16.0%** (58)	**23.1%** (11)	**16.1%** (71)	**16.9%** (82)
Transit Availability																	
High	27.0% (21)	18.9% (3)	26.4% (16)	25.1% (8)	27.4% (17)	22.5% (7)	26.2% (3)	25.9% (21)	n/a (0)	26.0% (24)	n/a (0)	26.0% (24)	20.3% (5)	26.8% (19)	38.2% (2)	24.9% (22)	26.0% (24)
Medium	13.7% (8)	8.0% (10)	19.0% (5)	9.6% (14)	11.2% (12)	13.6% (7)	10.5% (3)	13.5% (16)	20.5% (3)	10.5% (16)	12.1% (2)	12.1% (17)	19.6% (7)	7.7% (12)	15.0% (3)	11.5% (16)	12.1% (19)
Low	47.4% (2)	12.9% (38)	47.7% (1)	12.9% (38)	20.3% (13)	10.5% (26)	10.5% (6)	14.4% (33)	30.4% (1)	13.3% (38)	30.4% (1)	13.3% (38)	17.6% (12)	12.1% (27)	22.0% (6)	12.3% (33)	13.8% (39)
Level of Support																	
High	24.4% (15)	12.5% (17)	23.7% (11)	16.6% (21)	22.8% (15)	15.7% (17)	14.9% (4)	19.6% (28)	n/a (0)	19.0% (32)	n/a (0)	19.0% (32)	20.7% (11)	18.1% (21)	17.3% (7)	19.5% (25)	19.0% (32)
Medium	27.3% (7)	12.9% (26)	31.9% (5)	13.1% (28)	20.4% (16)	11.7% (17)	11.5% (7)	17.1% (26)	27.1% (3)	14.8% (30)	18.2% (3)	15.7% (30)	20.9% (8)	14.3% (25)	33.1% (4)	13.6% (29)	15.9% (33)
Low	22.8% (9)	9.6% (8)	24.0% (6)	10.2% (11)	17.8% (11)	10.0% (6)	44.2% (1)	13.2% (16)	10.5% (1)	15.3% (16)	n/a (0)	15.0% (17)	13.6% (5)	15.6% (12)	n/a (0)	15.0% (17)	15.0% (17)
Transportation Services																	
Transit	35.3% (2)	2.6% (2)	35.3% (2)	2.6% (2)	35.3% (2)	2.6% (2)	n/a (0)	18.9% (4)	n/a (0)	18.9% (4)	n/a (0)	18.9% (4)	21.1% (2)	16.7% (2)	42.4% (1)	11.1% (3)	18.9% (4)
Vanpool	34.1% (5)	10.7% (6)	34.1% (5)	10.7% (6)	25.0% (6)	17.0% (5)	23.1% (4)	20.3% (7)	n/a (0)	21.3% (11)	n/a (0)	21.3% (11)	30.7% (3)	17.8% (8)	13.8% (1)	22.1% (10)	21.3% (11)
Both	23.6% (4)	16.1% (7)	38.0% (2)	14.5% (9)	30.2% (5)	9.3% (6)	16.0% (2)	19.3% (9)	42.4% (1)	16.4% (10)	n/a (0)	18.8% (11)	3.4% (2)	20.0% (9)	n/a (0)	18.8% (11)	18.8% (11)
Co. Veh's.	36.6% (5)	14.6% (6)	34.8% (4)	18.9% (7)	34.4% (7)	7.6% (4)	16.4% (3)	27.5% (7)	38.9% (1)	23.2% (7)	n/a (0)	26.2% (9)	40.0% (4)	15.9% (7)	20.7% (2)	23.8% (9)	24.6% (11)
No Serv's.	18.2% (16)	11.3% (32)	15.6% (10)	13.1% (38)	13.1% (24)	14.2% (24)	5.8% (4)	14.3% (44)	17.7% (3)	13.4% (45)	18.2% (3)	13.3% (45)	13.5% (14)	13.7% (34)	19.2% (8)	12.5% (40)	13.6% (48)

Sources: Derived (see Appendix Table 19-A) from Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

Level of Transit Availability. Across the board, programs located in proximity to good transit service outperform those with medium to poor service. The 24 programs of all types favored with high transit availability have an average VTR of 26.0 percent, compared to only 12.1 percent for those with medium availability and 13.8 percent for those with low availability. Given a comparative advantage of high transit availability, particular incentives then either enhance or lessen VTR—or have negligible additional effect—based on their compatibility with transit use.

For example, parking pricing further encourages transit use. Programs with high transit availability and parking fees have an average VTR of 27.0 percent versus only 18.9 percent without priced parking. At the same time, offering parking discounts for HOVs is hardly an incentive to use transit, and accordingly there is only a small difference in VTR with or without the incentive (26.4 percent versus 25.1 percent). The same is true for vanpool subsidies, where the difference is 26.2 percent VTR with, versus 25.9 percent without.

In high transit availability cases transit subsidies are, logically, associated with a higher VTR (27.4 percent) than programs with no transit subsidies (22.5 percent). In the case of other monetary incentives, for whatever reason, the difference is even larger (38.2 percent with such incentives versus 24.9 percent without). No programs in the sample were observed to provide carpool or bike/walk subsidies in areas with high transit availability.

Programs in areas with medium or low transit availability also show positive impact on VTR from application of incentives like parking pricing, transit subsidies, and other monetary measures. Parking discounts for HOVs show a positive effect on VTR in the medium and low availability cases, illustrating the greater importance of HOV benefits where the transit alternative is less attractive. The travel allowance cases produce a somewhat curious result in that they show positive impacts on VTR for medium and low availability cases, but a negative effect where transit availability is high. Generally, the travel allowance provides for maximum user choice, and where transit service is at a maximum, one would expect that transit would be a preferred alternative.

Level of Employer Support. At all levels of employer support—from high to low—there is generally a demonstrably positive effect on VTR performance by providing incentives. This is certainly the case with regard to parking pricing, HOV parking discounts, and transit subsidies, and is true in most cases for carpool and bike/walk subsidies, travel allowances, and other monetary incentives. In the case of parking pricing, the effect on VTR seems to be almost independent of level of support, with low support programs registering a 22.8 percent VTR compared to 24.4 percent for high support programs, and both substantially higher than the equivalent programs without parking pricing (9.6 percent and 12.5 percent, respectively). HOV parking discounts and transit subsidies have a similar effect of increasing trip reduction almost independent of level of support, even though level of support shows a measurable VTR difference between high and low programs. Travel allowances seem to work better in combination with high or medium support levels and more poorly with low support levels. Oddly enough, in the 82-program sample, other monetary measures are associated with higher VTRs in the instance of medium support levels than they are in combination with high support levels.

Transportation Services. Once again, several of the financial incentives have a demonstrable, positive effect on the VTR performance of employer programs, in this case with respect to programs that provide transportation services. Parking pricing, HOV parking discounts, and transit subsidies again show evidence of a major additional VTR impact when combined with the respective transportation service. A number of combinations involve particularly low program sample sizes, however, requiring extra caution vis-à-vis individual VTR percentages.

Employer-enabled transit service, when combined with parking pricing, shows an average VTR of 35.3 percent compared to only 2.6 percent when parking is not priced. The differential is 34.1 percent with pricing versus 10.7 percent without when vanpool programs are the service provided, 23.6 percent versus 16.1 percent for combined transit and vanpool programs, and 36.6 percent versus 14.6 percent for service programs offering use of company vehicles. These VTR performance attainments exceeding 20 to 30 percent when parking pricing is applied contrast substantially not only with those programs that do not price parking, but also with programs that do not provide services, where VTR averages only 18.2 percent when parking is priced. These findings suggest an important combined benefit for mixing these two types of strategies. The same situation is evident for HOV parking discounts in combination with services and for transit subsidies with services. The various combinations appear to yield a much larger impact than either the monetary strategy or the transportation services strategy acting independently.

Additional Evidence of Transportation Incentive Effects

Parking Supply and Pricing. As revealed in the preceding analysis, the supply and price of parking serving a worksite have the single largest effect on the performance of employer-based TDM programs. Not only does limited parking or the existence of parking fees discourage solo driving outright, but such conditions also tend to increase the appeal of travel alternatives and other TDM strategies. Providing corroboration, a study of six San Francisco Medical Institutions found that the monthly charge for employee on-site parking was the single most influential factor in determining employee drive-alone rates. The monthly parking charge at each institution was also found to be highly correlated to the severity of off-site parking restrictions and the abundance of transit service (the second and third most important factors after parking pricing). An increase of $8 per month in employee parking charges was found to be necessary to decrease employee SOV mode split rates by one percentage point (Dowling, Feltham, and Wycko, 1991).

Because parking has such a powerful role, it is the exclusive subject of Chapter 13, "Parking Pricing and Fees," and Chapter 18, "Parking Management and Supply." These chapters offer substantially more information on the key role played by parking in employer and institutional TDM programs. In particular, see Table 13-22, "Relationship Between Parking Pricing and/or Subsidies and Vehicle Trip Rates at Employment Sites," and associated narrative, in conjunction with parking pricing. Likewise, see especially Table 18-8, "Parking and Transportation Characteristics at Six San Francisco Medical Institutions," in relation to parking supply.

Beyond the lessons of Chapters 13 and 18, further insight on the impact of parking and other financial incentives may also be derived from the 82-program sample, drawing upon the information on the composition of individual programs in Appendix Table 19-A. A subgroup of 56 sites, which incorporated some combination of financial incentives into their programs, has been extracted and tabulated in Table 19-12.

Table 19-12 Transportation Incentive Programs from the 82-Program Sample

Employer	Restricted Parking	Parking Fees	HOV Discounts	Parking Cash Out	Travel Allowance	Transit Subsidy	Other Subsidy	Other Incentives	VTR
Aetna – Hartford CT	Yes			TR subsidy		$21/mo.	VP Program		0%
Allergan						50%	100% VP	Rideshare Days Off, Raffles	13.8%
Atlantic Richfield Company – Los Angeles	Yes	$87/mo.	50% CP2 Free HOV3+		$15/mo.		Subsidized VP Program		34.5%
Arlington Heights, IL						$500/yr.	$500/yr.	Time Off	12.1%
AT&T – Silver Spring	Yes	Yes				Yes			24.0%
Bellevue, WA, City Hall	Yes	$30/mo.	Yes			Yes	VP $25/mo. CP/TR $15		30.0%
Bonneville Power Adm.	Yes	$25-40/mo.				$21/mo.			25.6%
Boulder, CO, Hospital						Yes	Yes		14.1%
Broadway Plaza 1	Yes	Yes	Yes			50%			5.6%
Broadway Plaza 2	Yes	Yes	Yes			100%			15.4%
Brown & Bain		$25-50/mo.	25%			50-75%			5.7%
CA Franchise Tax Board						$15/mo.	$25/mo. VP		5.6%
Cedars Sinai Hospital	Yes	Yes		Yes					12.6%
CH2M Hill - Bellevue	Yes	$56/mo.	Yes	.	$40/mo.	$15/mo.	$15/mo.		38.9%
Chubb Insurance							VP Program	Raffles	5.4%
City of Pleasanton, CA				$1/day		25%	25% VP	Raffles	5.6%
City of Simi Valley, CA					$2-3/day	$0.75/day	Bike Equip.	Time Off	43.5%
City Place Mall	Yes	Yes				Yes			26.7%
City/County of Denver	Yes	Yes	Yes			Yes	CP & VP		19.8%
Commuter Transp. Svcs.		$50/mo.			$40/mo.				17.5%
Comsis Corp.	Yes	Yes			$60/mo.	County	County		10.5%

(continued on next page)

Table 19-12 (Continued)

Employer	Restricted Parking	Parking Fees	HOV Discounts	Parking Cash Out	Travel Allowance	Transit Subsidy	Other Subsidy	Other Incentives	VTR
Cornell University	Yes	Yes				Yes	Yes		13.3%
GEICO	Yes	Yes				Yes	Yes		14.1%
Gotcha Sportswear								Time Off	34.1%
G-Street Fabrics						Yes			11.8%
Hartford Steam Boiler	Yes	$110/mo.	CP2 $75 CP3 $40 CP4+ $10			$10-30/mo.	$10-30/mo. Vanpool		36.4%
Heller Financial		$55/mo.	HOV3 Free					Time Off	15.6%
Hillsborough Co., FL						50%			3.4%
IT Corp. – Irvine, CA						100%	$50/mo. Ped.	Annual Drawing	12.1%
Johnson & Higgins	Yes	$180/mo.				$10/mo.			44.2%
Kirkland, WA, City Hall					$125/mo.				16.3%
Lawrence Livermore						$20/mo.			17.4%
Nat. Optical Observat.						50%			39.8%
Nike – Beaverton, OR	Yes					50%	$1/day		5.7%
NOAA	Yes	Yes				Yes			36.0%
Nuclear Reg. Comm.	Yes	$60/mo.				Yes			30.6%
P. L. Porter						$15/mo.			23.0%
Pacific Pipeline	Yes				$24/mo.				15.1%
Pasadena City Hall	Yes	Yes	Yes			Yes	Yes		18.5%
Puget Sound Blood Center	Yes	Yes	$25/mo. discount			50%		1 day/mo. Free park	42.4%
Rick Engineering						$25/mo.	$25/mo.		9.4%
Rockbestos							Vanpool		29.0%

Table 19-12 (Continued)

Employer	Restricted Parking	Parking Fees	HOV Discounts	Parking Cash Out	Travel Allowance	Transit Subsidy	Other Subsidy	Other Incentives	VTR
San Diego Trust	Yes	Yes	Yes			$60/mo.			22.7%
Shur-Lok Corp.						$21/mo	$10-20/mo. CP $25/wk. VP Bike/Walk		12.1%
So. California Gas	Yes	Yes	Yes		$50/mo.	$60/mo.			47.4%
State Farm Insurance				Paid to not park					30.4%
Swedish Hospital	Yes	$44/mo.	$22/mo.			100%	Yes		28.2%
TransAmerica	Yes	$62/mo.	$10/pool + $15/addt'l. passenger			$15/mo.			18.8%
Travelers - Hartford	Yes	$25/mo.	$15 CP2 Free CP3+			$15/mo.	$20/mo. VP (Program)		44.2%
Univ. of Washington	Yes	Yes	Yes			Yes	Yes		62.0%
US West – Bellevue	Yes	$60/mo.	$45 CP2 Free CP3+			Yes		Bike Equip. Rebates	31.3%
Varian	Yes					25%		Awards	17.4%
Ventura Co., CA								$1/day for not driving	13.3%
W. H. Mercer		$130/mo.	$91/mo.			100%	100% Ferry		22.7%
Walker Richer & Quinn						100%	60% VP or Ferry		0%
Warner Center Hilton						$15/mo.	$15/mo.		43.7%

Notes: CP = Car Pool, VP = Van Pool, TR = Transit.

Source: Appendix Table 19-A.

The data in this table not only provide a guide as to which sites have used particular incentives, but also help illustrate how varied the combination of incentive strategies is in practice. This variability, plus lack of uniformity in the way the various incentives are defined or measured, demonstrates why it has been difficult to isolate the contribution of individual incentive strategies.

In relation to parking, previous analysis indicated that those 39 sites with restricted and/or priced parking achieved an average VTR of 24.1 percent, versus 12.2 percent for those without parking controls. One way in which the incentive effect of parking pricing can be increased is by teaming it with strategies that further magnify the cost advantages of shifting travel modes. Two such strategies that have close linkages with parking pricing are parking discounts for HOVs and parking cash-out.

HOV Parking Discounts. HOV parking discounts offer employees who rideshare an additional cost advantage through reduced parking rates. Frequently these discount rates are scaled to the number of occupants, with HOVs of 3 or more often parking for free or at nominal cost. Sites in Table 19-12 that employed HOV parking discounts include: Atlantic Richfield Company—Los Angeles (34.5 percent VTR), Bellevue City Hall (30.0 percent), Broadway Plaza 1 (5.6 percent), Broadway Plaza 2 (15.4 percent), CH2M Hill (38.9 percent), City and County of Denver (19.8 percent), Hartford Steam Boiler (36.4 percent), Heller Financial (15.6 percent), Pasadena City Hall (18.5 percent), Puget Sound Blood Center (42.4 percent), San Diego Trust and Savings (22.7 percent), Southern California Gas (47.4 percent), Swedish Hospital (28.2 percent), TransAmerica (18.8 percent), Travelers Insurance (44.2 percent), the University of Washington (62.0 percent), US West (31.3 percent), and Wm. H. Mercer (22.7 percent). This combination of balancing fee-based disincentives with positive incentives has a clear impact on the success with which these programs reduce vehicle trips. Table 19-12 provides detail on the combination of strategies and circumstances which are at play in each of the examples and there is additional information in Appendix Table 19-A.

Parking Cash-out. Another strategy that works in tandem with parking pricing is parking cash-out, in which employees are given the option of exchanging the privilege of a free parking space for the cash equivalent, which they may then use flexibly to defray the cost of other transportation options including transit, walking, or biking. Such cash-out programs work best when employers are paying separately for parking, or where there is a parking shortage. The 82-program sample does not have many examples of parking cash-out as it is a relatively new TDM strategy. Only the City of Pleasanton, California, and Cedars Sinai Hospital officially cited cash-out programs. Aetna Insurance provided a $21 monthly transit subsidy in exchange for the employee's parking space, and State Farm Insurance in Orange County, California, took the unusual approach of paying employees *not to park* by offering cashable scrip linked to travel mode.

There are various studies of parking cash-out covered in Tables 13-12 through 13-14 of Chapter 13, "Parking Pricing and Fees." A 1997 study of eight parking cash-out programs in California found that total vehicle trips declined by 17 percent on average after a parking cash-out option was introduced at various urban and suburban work sites. This outcome was achieved by a reduction in drive-alone share from 76 to 53 percent, coupled with an increase in carpooling from 14 to 23 percent, transit from 6 to 9 percent, and bike/walk from 3 percent to 4 percent (Shoup, 1997).

Alternative Mode Subsidies. While parking has a powerful effect on vehicle trip making, its principal drawback is that it is very unpopular to implement proactively as a strategy. For employers located in areas with already restricted parking, pricing is more likely to be accepted as a fact of life for commuters. The one major difficulty would be in removing an existing parking subsidy when commuters have become accustomed to it. In contrast, in suburban areas where parking is generally not constrained, it is difficult to institute pricing without fearing a competitive disadvantage and loss of employees. Subsidies represent an important alternative way to use travel cost as a TDM strategy, since they encourage a desired behavior rather than discourage an undesired behavior. Of course, used in tandem, their effect is complementary, and the subsidy may allow the employer to also implement controls on parking. Parking fees, in turn, can provide the revenue source to fund the subsidies.

Federal and state tax incentive changes have made alternative mode subsidies more attractive for both employers and employees. Since 1984, Section 132(f) of the Internal Revenue Service (IRS) Code has authorized special treatment for commuter benefits. Initially, the law permitted employers to provide employees with a tax-free transit subsidy of up to $15/month. Meanwhile, employer-provided parking benefits had always been and remained fully tax exempt. Over time, the scope and amount of the alternative mode tax benefits have been steadily expanded. A major change occurred in conjunction with the Energy Policy Act of 1992 that raised the monthly employee tax-free transit subsidy limit to $60, included vanpools as an eligible mode, put a first-time ceiling on employer-provided parking of $155/month, and provided for inflation indexing. By early February of 2009, the non-taxable monthly transit/vanpool subsidy limit was $120, as compared to $230 per month for parking.

Transit/vanpool and auto commute mode federal tax treatment was equalized for the first time with the signing on February 17, 2009, of The Emergency Economic Recovery Act. This law raised to $230 per month the pre-tax income that employees in employer-sponsored commuter benefit programs can apply to payment for use of these alternative modes (TransitCenter, 2009). The tax deduction equalization does not extend to non-motorized transport, but there now exists a similarly applied $20 per month tax allowance for bicycling expenses (Los Angeles County Metropolitan Transportation Authority, 2009). Note that the timing of these new equalization and bicycling provisions is such that no program results reported in this chapter reflect these latest tax benefit enhancements.[8]

A number of states have also implemented tax incentive programs to encourage employers to provide transit or vanpool benefits to employees. These programs generally work to enhance cost savings for businesses. Examples range from a $25 annual tax credit for each employee receiving a commuter benefit in Georgia to $30 per employee per month for specified alternative mode benefits in Maryland (U.S. Environmental Protection Agency, 2005).

Transit Vouchers/Passes/Discounts. The easiest way to convey this employer subsidy is through transit vouchers or passes. Many metropolitan transit agencies actively administer transit pass programs designed to facilitate employers' efforts to provide subsidies to employees. A popular medium used in places like Philadelphia and New York City is TransitChek, in which an agreement between the employer and the transit agency provides employees with vouchers that can be used to buy tokens, tickets or passes from public or private transit operators (Comsis et al., 1996). Both Portland's TriMet and Seattle's King County Metro offer a similar set of instruments to entice employers and institutions to cost share in employees' or students' alternative mode costs.

Both the Portland and Seattle transit agencies market passes to private employers and universities by offering introductory discounts, although the primary discounting for the user is provided by

[8] During publication preparations for this chapter it was announced that direct federal grants (as contrasted to tax deductions) are being made through the new Energy Efficiency and Conservation Block Grant Program to government entities for, among other things, use in incentive programs to reduce commuting with single-occupancy vehicles (Institute of Transportation Engineers, 2009).

the employer/institution. Both agencies also offer a special instrument and program to employers who are required under state regulations to reduce vehicle trips. Metro credits its proactive pass programs with increasing regional use of non-SOV modes—principally transit, but also vanpool, carpool, and non-motorized—from 4.7 million to 6.7 million annual trips between 1997 and 1999. With its FlexPass program, Metro targeted 433 King County employers affected by the Commute Trip Reduction law. As of 2000, 120 employers were participating in the program, representing 80,000 employees, who took over 7 million transit trips in 2000. Over 2,300 vanpool riders also received an employer subsidy via their FlexPass in 2000 (Hansen and Slachowitz, 2001).

Some examples of subsidized transit pass efforts and the reported outcomes include the following (Comsis et al., 1996, or as indicated):

- First Hill (Seattle): A program serving employers in this area led to doubling of riders in a 12-month period. Of new riders, 60 percent formerly drove alone.

- Denver/Boulder: A total of 132 companies generated 9,648 new riders from introduction of an ECO Pass Program.

- Charlotte Uptown Council: A program of transit passes combined with other TDM measures gave employees at eight companies a choice between subsidized transit passes or parking. Transit ridership increased by 800 riders between 1989 and 1991.

- Cornell University: Discount passes to commuters living outside Tompkins County, combined with parking pricing, reduced vehicles parked on campus by 26 percent.

- University of Washington: The U-PASS discount program combined with more intensive bus service and higher parking fees increased the transit mode share by 81 percent (17 percentage points) and led to a 31 percent VTR as measured over the 1989–2004 period (see "University of Washington's U-PASS Program—Seattle, Washington" case study). AM peak period traffic counts taken in 2002 were 18 percent below 1983 levels (Association for Commuter Transportation et al., 2004). A transit pass program for Husky Stadium (free transit scrip for all ticket purchasers plus new park-and-ride services) increased game attendee transit share from 29 percent to 34 percent and dropped the auto mode share from 71 percent to 66 percent (Comsis et al., 1996).

- University of California (Los Angeles): Provision of an unlimited-access pass program, in the first year of promotion, increased commuting to campus via transit by 56 percent, decreased solo driving by 20 percent, and released at least 1,020 parking spaces (Georggi et al., 2007).

- Ann Arbor: A discounted or free transit pass program (depending on level of employer involvement), introduced to employees in the downtown between 2000 and 2001, reduced vehicle trips by 3.5 percent while bus passenger trips increased by 9.2 percent (Association for Commuter Transportation et al., 2004).

Reflecting again on the 82-program sample of employers provides additional insights on the role and impact of transit subsidies. Individual program examples featuring transit subsidies as their principal financial incentive measure have been selected from the tabulation for listing in Table 19-13. (This comparison is different from the Table 19-12 subsample because it takes transit availability into account.) An argument can be made that the impact of transit subsidies is likely to be greater if, in fact, there is good-to-reasonable transit service available to the site. Based also on the evidence that parking constraints (supply or pricing) have a strong disincentive effect on driving, the sample of sites has been divided into three groupings that are distinguished in relation to both transit availability and restricted parking.

Table 19-13 Comparative Impact of Transit Subsidies in Relation to Parking Controls and Transit Availability (VTR in Parentheses)

Medium and High Transit Availability (VTR)		Low Transit Availability (VTR)
Restricted/Priced Parking	**Free Parking**	**Free Parking**
AT&T Silver Spring (24.0%)	Aetna (0%)	Arlington Hts., IL (12.1%)
Bellevue City Hall (30.0%)	Boulder Hospital (14.1%)	Baxter Health Care (-3.3%)
Bonneville Power (25.6%)	G-Street Fabrics (11.8%)	California Franchise Tax Board (5.6%)
City Place Mall (26.7%)	IT Corporation (12.1%)	Dean Witter (5.4%)
Hartford Steam Boiler (36.4%)	Hillsboro County (3.4%)	GTE Systems (-3.3%)
Johnson & Higgins (44.2%)	Shur-Lok Corp. (12.1%)	Nike (5.7%)
NOAA (36.0%)	Walker Richer & Quinn (0%)	Rick Engineering (9.4%)
Nuclear Reg. Comm. (30.6%)		Washington Adventist Hospital. (-12.7%)
Swedish Hospital (28.2%)		
W. H. Mercer (22.7%)		
(Average VTR = 30.4%)	**(Average VTR = 7.6%)**	**(Average VTR = 2.4%)**

Note: A negative VTR implies that the sample program(s) had vehicle trip rates that were actually greater than the average from the surrounding area with which they were compared.

Source: Appendix Table 19-A.

In the Table 19-13 listing, those programs offering transit subsidies in the presence of both good transit and restricted parking have a significantly higher VTR (30.4 percent) than those with good transit but free parking (averaging a 7.6 percent VTR) or those with both free parking and limited transit availability (averaging a 2.4 percent VTR). Other details associated with these programs are found in Appendix Table 19-A.

A somewhat different take on the same question of transit pass program effectiveness in relation to the quality of transit service has been tested using Employee Commute Options survey data in Portland, Oregon. The researchers used a multiple regression approach to explore the relative importance of a list of employer-provided incentives—including particularly the transit agency's PASSport program—on employee transit mode share. TriMet's PASSport (introduced earlier in this section) allows employers to purchase transit passes for all employees at a cost based on only the number of employees who actually use transit.

The analysis, in addition to reflecting whether or not an employer offered PASSport to its employees and the proportion of cost paid by the employer, also considered the effects of transit proximity (within 1/4 mile of either a light rail transit (LRT) station or a frequent bus route), street connectivity (using an intersection ratio), and location of the worksite (in or out) in relation to Portland's "Fareless Square," a free transit zone covering downtown Portland and adjacent Lloyd Center. A dummy variable was used to reflect the offering of one or more other incentives such as flextime, CWW, guaranteed ride home, or company car (Dill and Wardell, 2007).

At the top of the list of key findings was that the location of an employer within the Fareless Square accounted for a 26 percentage point difference in transit mode share relative to employers not so located. (Note that the Fareless Square provides free transit rides internal to the zone but not for riding into the zone from outside or vice-versa.) As modeled on the full, unstratified data set, offering PASSport contributed 6.9 percentage points to transit mode share. Being within 1/4 mile of an LRT station added 4.1 percentage points, while being within 1/4 mile of frequent bus added 1.8 percentage points. Ideal street connectivity, relative to the worst encountered, added about 3.7 percentage points taking the variable construct into account.

Part of the reason that the Fareless Square was such an important determinant is thought to be its "urban" characteristics such as priced parking (on- and off-street) and more compact (and typically mixed-use) development patterns. When the study sample was split based on location relative to the Fareless Square, the PASSport incentive became worth 11.8 percentage points of transit share inside the fare-free zone versus 5.4 percentage points outside. Similarly, if the sample is split based on location within 1/4 mile of LRT, PASSport is worth 12 percentage points in transit share inside of the 1/4 mile range versus only 3.5 percentage points outside. Basically, the PASSport incentive has the greater effect on transit mode share where the employment location is more urban (with parking fees) and/or the transit service is better (Dill and Wardell, 2007).

Vanpool and Other Subsidies. Transit subsidies are clearly the most common alternate mode subsidies, in large part because of the favorable tax treatment they receive. Extension of comparable tax treatment to vanpools has increased the attractiveness of subsidy incentives to that mode, although most of these programs are already implicitly subsidized through the employer-provided vanpool program. Within the 82-program sample, 21 employers were identified as operating or facilitating an employee vanpool program. Employer-defrayed or shared costs in such areas as vehicle acquisition/financing, maintenance, insurance, fuel, and the like, already discussed under "Response to Employer Transportation Services"—"Employer-Assisted Vanpool Service," constitute in-kind subsidies. Monetary subsidies differing from these in-kind discounts may consist of vanpool-driver subsidies (to attract good volunteer drivers), empty-seat subsidies (to maintain a reasonable average fare level), or start-up subsidies.

Only seven of the 82 employers offered a vanpool subsidy among their incentives without actually operating a vanpool program: Bellevue City Hall, California Franchise Tax Board, the City of Pleasanton, City and County of Denver, Hartford Steam Boiler, Shur-Lok Corporation, and Walker, Richer & Quinn. In all of these seven cases, the stand-alone vanpool subsidy was offered along with a transit subsidy and often other financial incentives, such that its effect is difficult to separate. It is judged to be minimal.

Targeted subsidies to modes other than transit or vanpool are less common, probably because they have not been receiving favorable tax treatment. The sparse data make it difficult to generalize the traveler response. An example that does provide results for incentives as applied to various individual modes is the 1970s TVA program outlined earlier under "Response to Employer Transportation Services"—"Additional Evidence of Transportation Services Effects"—"Transportation Brokerage."

Table 19-8 listed the mode shares obtained before and after each stage of the program. The TVA example, although dated, is of particular interest because the transportation services were implemented as a first stage, and the incentives were provided as a second stage, allowing the impact of the incentives to be viewed in at least partial isolation.

Table 19-14 is designed to illuminate this additional perspective on the TVA results by highlighting the incremental percentage point changes in mode shares attained with incentives as contrasted to the initial mode shifts achieved with transportation services alone. Incentives included bus and vanpool fare subsidies and inexpensive parking for carpools. (Otherwise it is inferred that parking prices appropriate to the downtown location applied.)

Table 19-14 Mode Shifts by Stage of the TVA Transportation Brokerage Program

	Percentage Point Mode Share Changes					
Nature of Effect by Stage	**Drive Alone**	**Car-pool**	**Van-pool**	**Express Bus**	**Regular Bus**	**Other**
Combined effect of transportation services (without incentives) and first 1970s gas crisis	-23%	+10%	+2%	+11%	0%	0%
Additional (incremental) effect of incentives along with transportation services increases to meet increased demand	-24%	+1%	+5%	+17%	0%	+1%

Source: Adapted from Wegmann, Chatterjee, and Stokey (1979).

Response to the initial stage, services without incentives, was given an unexpected boost by the first 1970s fuel crisis and associated gasoline price increases. The second 1970s gas crisis was late enough in the decade that it did not occur between measurement of first stage results without incentives and measurement of the second-stage results with incentives (Pratt and Copple, 1981). This timing makes the shifts in response to incentives all the more notable.

Table 19-14 makes it clear that the mode shifts obtained for the vanpool, express bus, and other alternative modes, as well as the net effect on driving alone, were larger for the addition of incentives than for the original provision of transportation services. Only carpooling and regular bus ridership were largely insensitive to the incentives, perhaps because other alternative modes became more attractive. Although the effects of incentives were not boosted by additional gasoline price increases, they undoubtedly were enhanced by the vanpool and express bus service increases necessitated by the sheer volume of new users. Some of the incentives would have been worthless without the provision of transportation services. Prior to the program there was no express bus service or vanpool offering at all.

Typically, carpool subsidies are conveyed via a more general instrument, such as HOV parking discounts, parking cash-out, or transportation allowances, and—as with vanpool subsidies provided independent of a vanpool program—tend to be part of a broad package of financial and other incentives. The same is true with subsidies for biking, walking or other modes like ferry. In these situations too few observations are available or too many other measures are being applied to allow clear-cut attribution of impact to the subsidy.

Transportation Allowances. A transportation allowance is similar in function to parking cash-out in that it provides a sum of money that can be used at the employee's discretion toward the cost of his/her own chosen option, though the amount is not necessarily related to the employer's cost for parking. In the 82-program sample, 10 employers used some variation of parking cash-out or transportation allowances as part of their program. These 10 cases are among those detailed in Table 19-12. It is instructive to examine them with regard to how their program success may be related to the measures they applied:

- Southern California Gas (47.4 percent VTR), offered a $50/month Travel Allowance in conjunction with parking fees and HOV parking discounts.

- City of Simi Valley, California (43.5 percent VTR), used a $2–$3/day travel allowance, plus a $0.75/day bus subsidy, and a CWW policy with 90 percent employee participation.

- CH2M Hill in Bellevue, Washington (38.9 percent VTR), provided a $40/month travel allowance, plus a $15 subsidy for transit or carpool users, and restricted/priced parking.

- Atlantic Richfield Company in downtown Los Angeles (34.5 percent VTR), offered a $15/month travel allowance in conjunction with restricted and priced parking.

- Commuter Transportation Services in Los Angeles (17.5 percent VTR), used a $40/month travel allowance combined with parking fees.

- Kirkland, Washington, City Hall (16.3 percent VTR), had a $25/month travel allowance and parking fees.

- Pacific Pipeline (15.1 percent VTR), gave a $24/month travel allowance if an alternative mode was used at least 60 percent of the time, in a context of restricted/priced parking.

- Cedars Sinai Hospital in Los Angeles (12.6 percent VTR), used a parking cash out policy in conjunction with restricted and priced parking.

- Nike of Beaverton, Oregon, offered $1 per day for alternate mode use, but presumably because its parking was unpriced and unrestricted, its VTR was only 5.7 percent.

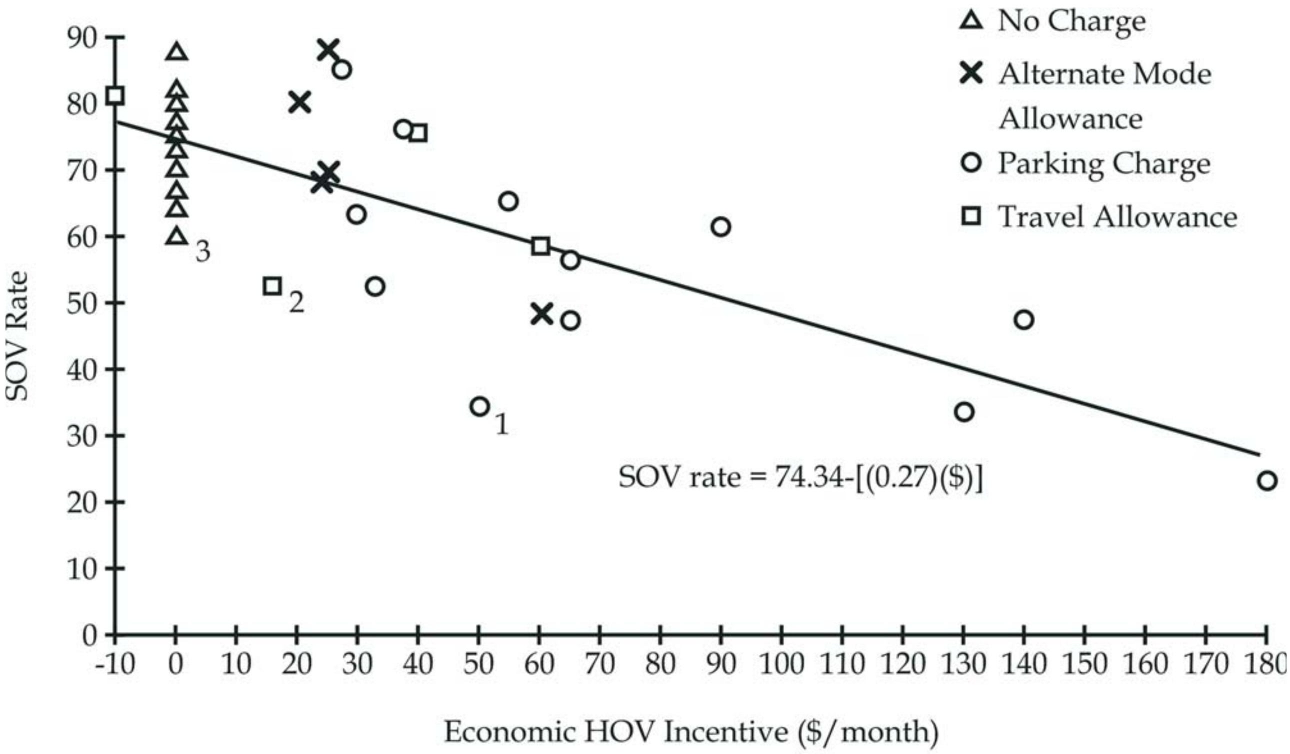
- Similarly, the City of Pleasanton, California, offered a $1/day cash-out incentive, but with unpriced and unrestricted parking, its VTR was only 5.6 percent.

Financial Incentive Experimentation. An experiment in Atlanta motivated by air quality objectives offers additional perspective on the role of financial incentives focused on the work commute. Implemented under the regional Clean Air Campaign and named "Cash for Commuters" (CFC), it was an incentive program that rewarded SOV commuters who agreed to switch to a commute alternative for a specified period of time. Eligible commuting alternatives included carpooling, transit, cycling, walking, or teleworking. Commuters who participated in the program could earn up to $180 in cash over a 90-day period at the rate of $3 per day that an alternative was used. Participants were required to live in the 13-county Atlanta region, register for the program, and affirm that they had not used any of the alternative commute modes more than 5 times during the preceding 90-day period. To receive compensation, participants were required to submit a travel log at the end of the enrollment period, which had to be verified and signed by the commuter's employer supervisor. Three separate program waves were conducted, during the 2002, 2003, and 2004 smog seasons, involving a total of 5,460 participating commuters.

An evaluation survey was conducted to track the behavior of the Wave 1 participants and gauge both initial impact on behavior and long-term effect on alternative mode-use rates. Prior to program enrollment, commuters in the Wave 1 group drove alone on 85 percent of their commute trips. During the period that they were receiving a CFC incentive, driving alone dropped to 14 percent of all trips, thus 86 percent of trips were made by an alternative. In 3 to 6 months after completing the CFC program, the proportion of drive-alone trips increased to 38 percent, by 9 to 12 months it reached 47 percent, and by 18 to 21 months after the program the drive-alone rate was at 53 percent. It appears that the financial incentive not only had a significant impact on initial disposition to use alternatives, but also led to a fairly high rate of alternatives use even 18 to 21 months past the time of the incentive offering (Center for Transportation and the Environment, 2004).

Financial Incentives in General. One attempt to sort out the relative importance of various economic incentives in employer TDM programs was made in the study of TDM at medium-sized employers that has contributed 38 employer case study examples to the 82-program sample. As illustrated in Figure 19-1, the researchers used linear regression analysis to estimate the relationship between the application of economic incentives and SOV rates (SOV commute mode shares). For the analysis, only economic incentives that apply to all employees were used to calculate a net HOV incentive. Parking charges and alternate mode travel allowances were counted as additive HOV incentives, whereas a general travel allowance was assumed to decrease the HOV incentive of a parking charge. In other words, if an employer had both a parking charge and a general travel allowance, the allowance is subtracted from the parking charge to get the net HOV incentive value. The resultant regression equation (sample size of 38, $r^2 = 0.54$) implies a reduction in SOV commuting rate of 0.27 percent for every $1 of monthly incentive (Rutherford et al., 1994).

Figure 19-1   Effect of economic incentives on SOV rates



Key
1 Reduced parking supply
2 Superior transit service
3 Alternative work hour program (two cases)

Source: Rutherford et al. (1994).

In-Kind Incentives. In lieu of cash, employers have attempted to encourage use of transportation alternatives through in-kind incentives with a tangible monetary value. The most popular among these methods are periodic raffles and time off with pay. Table 19-12 shows that 12 of the 56 employers in the 82-program sample who provided incentives offered some form of in-kind incentive. Allergan, Arlington Heights, the City of Simi Valley, Gotcha Sportswear, and Heller Financial all offered time off with pay for alternative mode use. Allergan, Chubb Insurance, the City of Pleasanton, IT Corporation, and Varian had raffles for alternative mode users, offering a chance at major cash or other prizes. Other interesting approaches include the Puget Sound Blood Center, which offered one day of free parking to qualifying alternate mode users; Ventura County and State Farm Insurance, who paid employees for not driving (similar to parking cash-out); and US West in Bellevue, which offered equipment rebates for bike commuters.

Unfortunately, it is difficult from the available data to quantify the effectiveness of these strategies on travel behavior, since in almost all cases they are grouped with one or more other strategies that would appear to have at least as great an impact as the in-kind measure. Only Ventura County, with a 13.3 percent VTR, and Gotcha Sportswear, with a 34.1 percent VTR, relied exclusively on their respective in-kind incentive for their TDM program.

A 1992 study by Commuter Transportation Services reported on the experience of five employers in the Los Angeles area who offered time off with pay as an incentive. As summarized in Table 19-15, there is a relatively modest financial value represented by these incentives. The first program, offered by the bank, seems to have been offering the highest incentive level and—probably not coincidentally—exhibited the highest VTR at 16.7 percent. Correspondingly, the software developer's program appears to have been offering the smallest incentive and had the lowest VTR achieved in the group (Stewart, 1992).

Table 19-15 Sample Programs Using Time Off with Pay as a Financial Incentive

Type Employer	Size	Time Off Policy and Requirements	Other Cash/Prize Incentives	Initial AVR	Update AVR	VTR
Bank	108	10 min. for each non-drive day; 40 hour/year max.	Quarterly $300 cash prize drawings	1.08	1.26	16.7%
Software Developer	150	1 point for every non-drive day (1/2 for 1-way ridesharing); 100 points = 1 day off; annual maximum = 16 hours	$10 monthly cash subsidy plus $100 gift certificate drawing if rideshare 75% of month	1.12	1.12	0%
Financial Services	250	Employees not driving alone 3 days per week for a month get to leave 1 hour earlier on a Friday the following month; annual maximum of 1 full day and 12 single hours	$20 and $40 cash subsidies and prize drawings for gift certificates	1.18	1.28	8.5%
Aircraft Parts	300	Employees not driving alone 3 days/week for 1 quarter receive 4 hours; 3 days/week for 4 quarters receive bonus day off; annual max. of 24 hours (3 days)	$10 monthly cash subsidy if rideshare average ≥ 3 days per week; monthly $100 gift certificate drawing	1.08	1.18	9.3%
Mortgage Provider	250	1 point for each non-drive day; 40 points earns 4 hours off; annual maximum of 24 hours (3 days)	Employees with 40 points in quarter enter drawing for 15 $50 checks plus free ice cream party	1.14	n/a	n/a

Note: AVR = Average Vehicle Ridership.

Source: Stewart (1992).

Response to Alternative Work Arrangements

Alternative work arrangement actions are strategies that modify the time at which travel occurs or the frequency of travel. From a TDM perspective, their objective is either to reduce the concentration of travel in a peak travel period or to reduce the overall number of trips made on a daily or weekly cycle to an employment site. The strategies included in this group were defined in the

“Overview and Summary” section under “Types of TDM Strategies,” but a quick review of important characteristics will assist in interpretation of their effects:

- Flexible work hours are where employees are given freedom in choosing their starting and quitting times. Flextime programs fall into two important groups, those where employees are allowed to adjust their arrival and departure times in order to avoid traveling during the most congested time periods, and those where employees are explicitly permitted to adjust their schedules to meet transit, carpool, or vanpool scheduling requirements. Most of the programs reviewed here are of the latter type, designed essentially as an incentive (removal of an impediment) to use an alternative mode. General shifting of work hours to avoid congestion is less common, although it was an important strategy for meeting the requirements of peak traffic reduction ordinances common in the late 1980s.

- Staggered work hours are generally unique to large employers, where some departments or employee groups are assigned to a different but set work day schedule to reduce the impact of having all employees arriving at or departing the site at the same time. This is not to be confused with shift schedules, such as are found at large manufacturing establishments or health centers, which are for purposes of evening and night staffing, not travel management. Neither should it be confused with flexible work hours, which are discussed in the preceding paragraph.

- Compressed work week (CWW) programs enable employees to work fewer days per week (or bi-week) in exchange for working longer hours each day. The two most common arrangements are the 9/80 schedule, where employees work a 9-hour day and receive the tenth day of the 2-week cycle off, and the 4/40 arrangement, where employees work four 10-hour days and receive the fifth day off. In both cases, the transportation benefit is that the employee is able to forego physical commutation to the work site one day per cycle. A secondary benefit is that the longer work day pushes the timing of the commute trip outside the standard peak period as defined by 8-hour work days.

- Telecommuting, also known as telework, allows the employee to work from home some number of days per week or month, usually by virtue of an electronic connection that keeps the employee in continuous real-time contact with the work site. A less common alternative is where the employee works from a special satellite “telework” center.[9]

Alternative Work Arrangements Insights from the 82-Program Sample

A key question regarding alternative work schedule strategies is whether or not they are supportive of TDM strategies that encourage use of alternative modes and thereby reduce vehicle trip rates and, if not, whether their introduction leads to a net reduction or gain in vehicle trips. Alternative work arrangements that allow employees to synchronize their work schedules with the demands of an alternative mode are designed to explicitly encourage alternative mode use. Conversely, policies

[9] Telecommuting evaluation is complicated by the fact that there are three distinct forms of working at home, of which telecommuting is only one. Another is home-based-business (HBB) workers, self-employed individuals who operate or manage their business primarily from the home. HBB workers may or may not be segregated out from telecommuters in surveys, research, and summaries. The third form is overtime homeworkers, who go to the formal workplace but bring home work to do, primarily outside of normal working hours. This third kind is of little interest to transportation planning, because it does not have much effect on the occurrence of travel (Tang, Mokhtarian, and Handy, 2007).

that allow employees to shift their travel outside of the peak, CWW, and telecommuting may or may not detract from the appeal of alternative mode use by either reducing the pressure of peak-period congestion or disrupting a routine daily schedule that might better support ridesharing arrangements and transit use.

Ability to ascertain the net effect of these potentially opposing outcomes from the 82-program sample is impeded by the nature of the data as it pertains to CWW programs and telecommuting. The data limitations involved were highlighted in the "Analytical Considerations" discussion of the "Overview and Summary" and have been referred to in previous "Response by Type of Strategy" subsections. To summarize, in virtually all cases within the 82-program sample, there is only sufficient employer survey data to calculate a vehicle trip rate based on modal split reported for commute trips which actually occur. To do more, it would be necessary to know exactly what type of CWW arrangement the employee opted for (4/40 or 9/80 arrangement), or how many days per week the employee telecommuted. Although in some cases there may be an indication of the percentage of employees who are using the measures in question, none of these cases offers the details necessary to calculate the net effect on bottom-line vehicle trip rates.

To illustrate the interplay of mode shift and trip elimination effects involved, assume an employee has been commuting 5 days per week in a two-person carpool. He/she has been generating the equivalent of 0.5 vehicle round trips per day. Now the employee is offered a telecommuting choice, and chooses to work from home 2 days per week. That eliminates two commute round trips outright. However, if that employee now opts to make the three weekly trips to the worksite by driving alone, she now averages 0.6 vehicle trips per day—a 20 percent *increase* in the daily vehicle trip rate, apart from any increase in non-work travel which may be occurring on telecommute days. However, if the employee were required to remain in the pre-existing two-person carpool arrangement, the average daily vehicle trip rate would only be 0.3, which would qualify as a 40 percent trip *reduction*. Obviously, accounting for the precise combination of strategies and resulting changes in behavior is critical to determining the net effect of CWW and telecommuting on vehicle trip making. For analysis it would be necessary to have a record of the commuter's behavior on each day of the travel "cycle" in question. In most cases this would be a 5-day week, though in the case of a 9/80 compressed work week it would be longer.

In the 82-program sample, only the average vehicle trip rate for a "typical" day can be ascertained, and not in full consideration of the combined effect as depicted above. Mode shifts are taken into account (such as the shift from two-person carpool to drive alone in the example above) but trips eliminated outright cannot be (such as the 2 telecommute-day trips not made in the example). It is important to be aware of this distinction when reviewing the calculation results provided in Table 19-16 and the following discussion on relationships observed in the 82 example programs. The data limitations lead to an understatement of overall CWW and telecommute vehicle trip travel savings, but they do directly shed light on the issue of variable work hours effects on alternative mode use.

Overall Effect of Alternative Work Arrangement Strategies. Table 19-16 summarizes the comparative trip reduction performance among the 82 examples from the perspective of alternative work arrangement strategies. Focusing first on the boldface "All" row in the table, the VTR performance of each of the four alternative work schedule strategies—shown *with* and *without* the respective strategy in place—can be compared. What is evident is that only in the case of flexible hours is the calculated VTR substantially greater in the presence of the strategy than without it. Of employers in the 82-program sample, 45 offered flexible hours and averaged 20.1 percent VTR, compared to 13.1 percent VTR for the 37 employers where it was not offered. With staggered hours, only seven employers offered this program, and they averaged a 15.9 percent VTR compared to 17.0 percent for the 75 who did not. With CWW, the 54 employers who offered the program averaged a calculated VTR of 15.8 percent, well below the 19.1 percent VTR for the 28 who did not, but not necessarily less effective given the computational limitations described above. For telecommuting, the 65 who offered the program had an average calculated VTR of 17.1 percent, barely above the 16.5 percent for the 17 who did not. Again, the CWW and telecommuting calculations reflect only mode shifts and not trip avoidance effects.

Alternative Work Arrangements in Relation to Transit Availability. Flexible hours seem to have their positive impact only when applied in the presence of medium or low transit availability. Perhaps this is where employees who would use transit find the transit schedules least accommodating, and thus are more substantively aided by work hours flexibility. In high transit availability areas there is less than a percentage point of difference in average VTR between programs with flexible hours and those without.

Programs offering staggered hours have the opposite relationship with transit availability. Staggered hours implemented in the presence of high transit availability exhibit a difference in average VTR of only 1.5 percentage points with versus without staggered hours. However, for those situations where transit availability is medium or low, the programs where staggered hours are not offered have higher average VTRs than those where they are. It should be noted that these latter staggered hours programs are represented by very small sample sizes.

Both CWW and telecommuting have marginally better VTR performance, as computed on the basis of mode shifts alone, when implemented with high transit availability. For CWW, programs with high transit availability average a VTR of 27.4 percent, compared to 25.1 percent without. Programs with telecommuting average a VTR of 26.4 percent with high transit availability versus 25.9 percent without. At medium and low transit availability levels the effects vary as to whether the work schedule program is associated with a positive or negative difference.

Alternative Work Arrangements in Relation to Level of Employer Program Support and Employer Transportation Services. No clear or intuitive relationships emerge from examining alternative work arrangements in the context of employer support levels. For the most part, the same must be said for combinations involving transportation services. In the case of transportation services, particularly small sample sizes impede the effort to reach substantive conclusions.

Table 19-16 Vehicle Trip Reduction Percentages Related to Alternative Work Schedules

Other Conditions or Programs	VTR by Type of Alternative Work Schedule Offered (Sample Size)								
	Flexible Hours		Staggered Hours		Compressed Work Week		Telecommuting		
	With	W/out	With	W/out	With	W/out	With	W/out	All
All	**20.1%** (45)	**13.1%** (37)	**15.9%** (7)	**17.0%** (75)	**15.8%** (54)	**19.1%** (28)	**17.1%** (65)	**16.5%** (17)	**16.9%** (82)
Transit Availability									
High	25.8% (16)	26.4% (8)	27.2% (4)	25.7% (20)	27.4% (9)	25.1% (15)	26.4% (3)	25.9% (21)	26.0% (24)
Medium	15.4% (10)	8.3% (9)	-12.7% (1)	13.4% (18)	2.4% (2)	11.6% (15)	15.1% (2)	10.0% (2)	12.1% (19)
Low	17.9% (19)	9.9% (20)	7.7% (2)	14.1% (37)	15.6% (15)	12.6% (24)	12.5% (11)	14.4% (28)	13.8% (39)
Level of Support									
High	17.9% (24)	22.6% (8)	18.1% (2)	19.1% (30)	19.7% (15)	18.4% (17)	18.6% (10)	20.1% (22)	19.0% (32)
Medium	21.9% (17)	9.5% (16)	22.9% (2)	15.5% (31)	21.5% (10)	13.5% (23)	14.6% (6)	16.2% (27)	15.9% (33)
Low	26.3% (4)	11.6% (13)	9.9% (3)	16.1% (14)	8.3% (3)	16.5% (14)	28.2% (1)	14.2% (16)	15.0% (17)
Transportation Services									
Transit	35.3% (2)	2.6% (2)	28.2% (1)	15.8% (3)	20.5% (3)	14.1% (1)	28.2% (1)	15.8% (3)	18.9% (4)
Vanpool	18.5% (6)	24.7% (5)	n/a (0)	21.3% (11)	22.2% (3)	21.0% (8)	9.6% (2)	23.9% (9)	21.3% (11)
Transit & Vanpool	15.6% (6)	22.6% (5)	11.9% (2)	20.3% (9)	15.4% (2)	19.5% (9)	14.5% (3)	20.4% (8)	18.8% (11)
Use of Co. Vehicles	28.0% (10)	< 0% (1)	n/a (0)	24.6% (11)	24.2% (7)	25.4% (4)	16.4% (4)	26.2% (7)	24.6% (11)
No Services	17.9% (25)	9.7% (25)	14.9% (4)	13.5% (44)	16.2% (16)	12.3% (32)	14.6% (8)	13.4% (40)	13.6% (48)

(continued on next page)

Table 19-16 (Continued)

Other Conditions or Programs	VTR by Type of Alternative Work Schedule Offered (Sample Size)								
	Flexible Hours		Staggered Hours		Compressed Work Week		Telecommuting		
	With	W/out	With	W/out	With	W/out	With	W/out	All
Incentives									
Restricted Parking	28.5% (20)	19.2% (15)	19.2% (5)	25.4% (30)	29.1% (11)	22.5% (24)	26.5% (5)	24.3% (30)	24.6% (35)
Parking Fees	25.2% (21)	23.4% (10)	27.2% (4)	24.2% (27)	28.2% (11)	22.3% (20)	24.7% (6)	24.6% (25)	24.6% (31)
HOV Discounts	24.0% (16)	30.2% (6)	21.1% (2)	26.1% (20)	29.0% (8)	23.7% (14)	29.5% (4)	25.0% (18)	25.7% (22)
Transit Subsidy	23.9% (26)	15.2% (16)	16.2% (6)	21.3% (36)	24.7% (15)	18.3% (27)	24.4% (6)	19.9% (36)	20.6% (42)
Vanpool Subsidy	11.2% (6)	19.5% (6)	7.7% (2)	17.2% (10)	8.3% (3)	15.5% (9)	8.3% (3)	17.7% (9)	15.3% (12)
Travel Allowance	23.9% (14)	12.8% (10)	21.1% (2)	19.1% (22)	24.4% (9)	16.2% (15)	17.8% (8)	20.1% (16)	19.3% (24)
Other Monetary	24.8% (9)	15.4% (2)	n/a (0)	23.1% (11)	29.2% (5)	18.0% (6)	12.9% (2)	25.3% (9)	23.1% (11)
In Combination with Other Work Hours Programs									
Flexible Hours			27.2% (4)	19.5% (41)	24.2% (21)	16.6% (24)	19.1% (12)	20.5% (33)	20.1% (45)
Staggered Hours	27.2% (4)	0.9% (3)			17.5% (5)	11.9% (2)	16.9% (2)	15.5% (5)	15.9% (7)
Comp. Work Week	24.2% (21)	4.1% (7)	17.5% (5)	19.5% (23)			17.1% (13)	20.9% (15)	19.1% (28)
Telecommuting	19.1% (12)	10.4% (5)	16.9% (2)	16.5% (15)	17.1% (13)	14.6% (4)			16.5% (17)

Note: Compressed work week and telecommuting VTRs as calculated reflect only mode shift effects and not trip elimination benefits.

Sources: Derived (see Appendix Table 19-A) from Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

It can be said, however, that programs offering vanpool or vanpool-plus-transit services perform better overall without work hours strategies than in their presence. Employer programs without any transportation services are the ones that appear to do better with alternative work arrangements strategies. Among programs without services the highest calculated VTRs are found in the presence of flexible hours (17.9 percent VTR with versus 9.7 percent without) and CWW (16.2 percent VTR with versus 12.3 percent without).

Alternative Work Arrangements in Relation to Parking Pricing and Management. The top portion of the second page of Table 19-16 highlights the effects of alternative work hours strategies when combined with restricted parking, parking fees, and HOV parking discounts. Of the 35 programs with restricted parking, 20 also featured flexible hours, five had staggered hours, 11 offered CWW, and five had telecommute programs. In all cases except staggered hours, the work hours strategy is associated with a greater VTR when it is included than when it is not. Restricted parking with flexible hours exhibits an average VTR of 28.5 percent compared to 19.2 percent without flexible hours; restricted parking with CWW has a 29.1 percent VTR versus 22.5 percent without; and restricted parking with telecommuting added has a slightly higher VTR with (26.5 percent) versus without (24.3 percent). As a reminder, these VTRs are computed with reference to mode shifts alone. Where staggered hours are found with restricted parking the VTR is 19.2 percent compared to 25.4 percent without.

The apparent effect of linking work hours strategies with parking fees is similar in pattern to that of restricted parking, but less pronounced. Flexible hours found in the presence of parking pricing yields an average VTR of 25.2 percent, versus 23.4 percent without flexible hours. Staggered hours in this case exhibits a positive association, showing an average VTR of 27.2 percent with staggered hours and 24.2 percent without. CWW teamed with parking fees has a VTR of 28.2 percent, compared to 22.3 percent without CWW. Telecommuting has the most neutral association of the work hours strategies, showing essentially no difference between programs with versus without parking pricing when examined on the basis of mode shifts alone.

Finally, variable hours in relation to HOV parking discounts present a mixed bag. Table 19-16 indicates that HOV parking discounts exhibit higher VTRs in the presence of CWW and telecommuting than without, while the opposite occurs in the presence of flexible and staggered hours. Exactly why this may be is unclear. With CWW and telecommuting, the direction of the effect is consistent with the restricted parking and priced parking relationships, but with staggered hours and particularly flexible hours, it is not.

Alternative Work Arrangements in Relation to Modal Subsidies. Flexible hours appear to combine well with transit subsidies, travel allowances, and other monetary incentives, but not with vanpool subsidies. This parallels the earlier observation that flexible hours seem to have a positive relationship with employer-provided transit service, but a negative effect with vanpool and transit/vanpool. The same is seen for CWW, with VTR impacts complementary for all incentive strategies but vanpool subsidies. Telecommuting shows a positive effect only with transit subsidies, as calculated on the basis of mode shifts alone. Finally, staggered work hours show a positive effect only with the travel allowance incentive.

Alternative Work Arrangements in Relation to Each Other. The final comparison in Table 19-16 examines the outcome when different alternative work hours strategies are combined with each other. Note that to read and interpret this table, the same rules of order apply as in the preceding comparisons: For a program with the strategy listed as a row, each VTR number in the row corresponds to the average observed when the strategy listed as the corresponding column is or is not applied. To illustrate, of the 45 employer programs offering flexible hours, four of those programs also included staggered hours (presumably for different employees). They have an average VTR of 27.2 percent, while those without staggered hours average 19.5 percent. (One might well surmise that the reason for the significantly enhanced performance of these particular four programs is something more than just inclusion of a staggered work hours strategy.)

Reviewing the table, flexible hours programs exhibit a higher calculated VTR when combined with staggered hours (27.2 versus 19.5 percent VTR) and CWW (24.2 versus 16.6 percent), but not when telecommuting is offered (19.1 versus 20.5 percent). Staggered work hours programs are apparently enhanced by the addition of each of the other work hours strategies. CWW programs are found to perform better when combined with flexible work hours (24.2 versus 4.1 percent). The sampled CWW programs exhibit somewhat lower efficacy in combination with staggered hours and telecommuting. Like staggered hours, telecommuting programs appear to be enhanced with the addition of any of the other work hours programs. They exhibit higher VTRs in the presence of flexible hours (19.1 versus 10.4 percent), staggered hours (16.9 versus 16.5 percent), and CWW (17.1 versus 14.6 percent).

As stressed in the introduction to this discussion, all combinations involving compressed work hours and telecommuting would be associated with higher VTRs than reported above and in Table 19-16 were it possible to include the effect of trips eliminated outright in computations made with the 82-program sample. It is thus particularly important to make full use of such additional research evidence as it is available, which is the subject of the next subsection.

Additional Research Evidence on Alternative Work Arrangements

While alternative work arrangement strategies like flexible work hours, CWW, and telecommuting are widely applied as TDM strategies, the amount of quality public information providing a quantitative insight into the effectiveness of these programs is surprisingly limited—most particularly for recent years. This research shortcoming notwithstanding, this subsection supplements the preceding descriptive analysis of the 82-program sample with a selection of individual studies out of the literature that offer additional information on this important category of TDM strategies. While some of these examples are rather dated, several represent carefully constructed experiments, and their value—as should be evident—is not necessarily diminished by time.

The one major question with respect to the older studies, especially those from the 1970s, is whether and to what extent the fresh ground plowed by the early experiments and demonstrations focused on mitigating traffic peaking still exists. The U.S. Department of Labor data reviewed immediately below suggests that the baseline ambient peak-spreading effects of flextime in particular must now be more extensive than earlier. The further peak-spreading possibilities for alternative work hours may thus be diminished by the smaller remaining increment of potential. The degree to which this may pertain can be assessed in individual cases by determining the amount of travel peaking found in the "before" condition. Note that the concern expressed here is much less likely to be of importance with regard to either mode shift or trip reduction findings/outcomes.

Flexible Work Hours. The U.S. Department of Labor has reported that, in 2002, almost 29 percent of the U.S. workforce of full-time wage earners and salaried employees had schedules permitting them to vary the time they begin or end their day. Interestingly, only about one-third of those employees worked for companies with official flextime policies. The proportion of such workers has grown slightly since the U.S. Department of Labor's previous survey in 1997, when 26.6 percent reported working flexible schedules. More striking is the comparison with 1991, when just 15 percent of workers had flexible hours options. Flexible schedules were found, in 2002, to be most common among executives, administrators and managers, with 45.5 percent able to vary their schedules. Almost 41 percent of sales personnel were also able to adjust their schedules (Associated Press, 2003).

At Bishop Ranch in exurban San Francisco, flextime policies were a major part of employee commute assistance programs for major employers relocating to this business park from downtown San Francisco. Faced with a local traffic management ordinance requiring a reduction not only in vehicle trips, but also in the number of those trips occurring in the peak hour, flextime was found to be very effective in shifting employee arrival times to less congested periods. A survey of 14,800 employees 2 years after the opening of Bishop Ranch showed an increase from 8 percent to 17 percent in the percentage of employees starting work before 7:00 AM. The percentage starting after 9:00 AM increased from 1 percent to 9 percent. Departure peaking also was reduced, with the percentage of workers leaving before 4:00 PM increasing from 12 percent to 17 percent (Beraldo, 1990).

About 6,000 employees from 23 San Francisco employers participated in a broad-scale trial offering of flextime in the 1980s. Post-implementation surveys showed at least one-half of the participants arriving to work 30 or more minutes earlier than before flextime, with many arriving before 7:00 AM. By traveling before the main peak period, those arriving by car or by carpool saved an average of 9 minutes each trip, with over 60 percent reporting much less congestion on the way to work (Jones, 1983).

The larger trial in San Francisco was preceded by the Downtown San Francisco Flextime Demonstration Project. Through surveys of participating employees, researchers found that the start-time peaks of three employers offering flextime were significantly smaller than the peak for downtown employees as a whole and/or they occurred *before* the downtown peak. Employers surveyed included the California State Automobile Association (CSAA), Metropolitan Life, and Fireman's Fund, with findings as illustrated in Table 19-17. The peak 30-minute arrival period for downtown employees as a whole was 8:00 to 8:30 AM. Of all employee arrivals, 61 percent occurred during that period. Among variable work hours participants, the CSAA employee arrival peak was 40 percent, during the same time period; the Metropolitan Life peak was 53 percent, occurring between 7:00 and 7:30 AM; and the Fireman's Fund peak was 34 percent between 7:30 and 8:00 AM (Harrison, Jones and Jovanis, 1979). This experience provided early corroboration with other evidence that typical flextime employees in the United States, as well as in Germany's extensive programs, select earlier arrival schedules than the pre-existing norm (Pratt and Copple, 1981).

In 1978, the U.S. Department of Transportation's Transportation System Center (now Volpe Center) in Cambridge, Massachusetts, conducted a 1-year experiment of flextime offered to its 600-person staff. It was able to stage an evaluation of the test using the monitoring resources of its Service and Methods Demonstration program.

Table 19-17 Employee Arrival Times at Three San Francisco Employers Adopting Variable Work Hours

Arrival Time	Fireman's Fund (Self-Staggered Start)	CSAA (Flextime)	Metropolitan Life (Flextime)	All Downtown Employees
7:00 – 7:30 AM	31%	16%	53%	8%
7:30 – 8:00 AM	34%	31%	24%	13%
8:00 – 8:30 AM	20%	40%	14%	61%
8:30 – 9:00 AM	10%	7%	6%	1%
After 9:00 AM	5%	6%	3%	17%
Total	100%	100%	100%	100%

Note: Earliest sanctioned arrival time at CSAA was 7:30 AM.

Source: Harrison, Jones, and Jovanis (1979).

Beginning in March 1978, Transportation System Center employees were given the flexibility to shift their time of arrival from the existing 8:15 AM to a larger period extending from 7:00 AM to 9:30 AM. A core workday of 9:30 AM to 4:45 PM was maintained, and employees could arrive and depart when they chose around these hours so long as they worked a full 8-hour day with a mandatory 30-minute lunch period.

The majority of employees opted to adjust their schedules under this arrangement, shifting the mean arrival time to 7:55 AM. The distribution of arrival times around this mean was fairly symmetrical, with a 32-minute standard deviation. About 56 percent arrived at or before 8:00 AM, and 14 percent at or after 8:30, meaning that 30 percent arrived in the 8:00 to 8:30 time frame. In this program, employees were also allowed to vary their schedules from day to day without prior approval. This feature showed surprising variation, with more than one-half of all workers deviating more than 10 minutes from their mean arrival time more than one-half of the time. Among the reasons given for adjusting their schedules, the top two reasons were "to accommodate after-work activities" (72 percent of all responding) and "avoiding traffic congestion" (cited by 69 percent of respondents) (Ott, Slavin, and Ward, 1980).

In September 1974, the Port Authority of New York and New Jersey began a flexible hours experiment that lasted 8 months and involved about 850 headquarters staff. Those involved in the experiment included employees previously on staggered hours and also those on a normal work schedule. The basic 5-day work week remained unchanged for flexible hours program participants. The total expanded day covered the period between 8:00 AM and 5:30 PM, during which time employees were required to be at work for a core period between 9:30 AM to 4:00 PM. Workers were given 45 minutes for lunch. The 1-1/2 hour periods preceding and following the core period were flexible periods within which the employee could vary time to any extent, as long as a 40-hour work week requirement was fulfilled.

To support evaluation, arrival and departure counts were made before and after the experiment, for both participants and also two control groups of employees whose work schedule (floating day and normal) did not change. Because the different participating and control groups also worked on separate floors, arrival and departure times by floor could be meaningfully compared, as illustrated in Table 19-18. Fifteen-minute work floor arrival and departure peaks were decreased by 13 percentage points (from 31 percent to 18 percent) and 10 percentage points (from 35 percent to 25 percent), respectively, on floor A, where the majority of employees changed from a conventional fixed schedule to flextime. Meanwhile, peaking changes were insignificant on the floors that changed from staggered hours to flextime (Port Authority of New York and New Jersey, 1975).

Table 19-18 Port Authority of New York/New Jersey Flextime Experiment—15-Minute Peaking Before and After Flexible Work Hours

	Peak 15-Minute Arrivals		Peak 15-Minute Departures	
Work Floor / Work Hours Programs	**Percent of 7:30-10:00 AM Arrivals**	**Peak AM Time Period**	**Percent of 3:30-6:00 PM Departures**	**Peak PM Time Period**
Floor "A"				
Before (Conventional Hours)	31%	8:45-9:00	35%	4:30-4:45
After (Flexible Hours)	18%	8:45-9:00	25%	4:30-4:45
Floor "B"				
Before (Staggered Hours)	20%	8:15-8:30	26%	4:00-4:15
After (Flexible Hours)	20%	8:15-8:30	27%	4:00-4:15
Floor "C"				
Before (Staggered Hours)	28%	8:15-8:30	25%	4:00-4:15
After (Flexible Hours)	24%	8:30-8:45	26%	4:15-4:30
Floor "D" (control)				
Before (Floating Day)	24%	8:15-8:30	30%	4:00-4:15
After (Floating Day)	29%	8:15-8:30	25%	4:00-4:15
Floor "E" (control)				
Before (Conventional Hours)	27%	8:30-8:45	30%	4:15-4:30
After (Conventional Hours)	27%	8:15-8:30	28%	4:15-4:30

Note: Arrivals and departures were surveyed on the individual work floors. The surveys included some employees not participating in the flexible work hours experiment.

Source: Port Authority of New York and New Jersey (1975).

The association between allowing flexible arrival/departure times and employee choice of mode is somewhat unclear, and may depend significantly on the conditions placed on the flextime policy by the employer or institution. In many of the examples within the 82-program sample, flextime was a special privilege made available to employees using alternative modes, with flextime intended to provide additional latitude for accommodating the schedules of transit service or of a ridesharing unit. Indeed, the regional rideshare agency in the San Francisco Bay area found the placement rate among its rideshare applicants on flextime to be 30 percent compared to 16 percent for applicants not on flextime (Burch, 1988).

In the Transportation Systems Center flextime study described above, 9 percent of workers were found to have changed modes due to flextime, with a small net change in favor of ridesharing (+2.0 percent) and transit (+1.0 percent) and a reduction in driving alone (–3 percent), primarily attributed to savings in travel time offered by a schedule shift (Ott, Slavin, and Ward, 1980). Employee surveys in Pleasanton, California, suggested that only 7.6 percent of workers under flextime also rideshare, compared to 11.4 percent of the entire Pleasanton workforce (Cervero, 1988). Another study covering flextime, as introduced at the Tennessee Valley Authority (TVA), suggests a 2 percent loss in vanpool ridership paired with a much larger loss in bus ridership. Vanpoolers adjusted vanpool schedules to meet rider preferences for earlier arrivals, but bus schedules were not changed in a similar way, and bus ridership fell by 21 percent (Wegmann and Stokey, 1983).

In-depth survey results for the CSAA organization (see Table 19-17 for arrival times) showed that flextime had especially aided work trip ridesharing among friends and family, a particularly resilient form of carpooling (Harrison, Jones, and Jovanis, 1979; Pratt, Pedersen, and Mather, 1977). Among six early implementers of flextime in the San Francisco Bay Area, ride-sharing was the big beneficiary, with shared-ride increases ranging from 1 percent to 28 percent.[10] Drive-alone activity decreased in all cases, with declines between 3 and 26 percent for the three employers with significant drive-alone activity. Transit mode share impacts were mixed, with shifts ranging from –22 percent to +8 percent, with three losers and three gainers (Harrison, Jones, and Jovanis, 1979; Jovanis and May, 1979).

The early observation that "The majority of actual before and after survey data . . . indicates at worst an insignificant or neutral effect on single occupant auto usage and gives some evidence of a predominance of mode shifting to carpools" (Pratt and Copple, 1981) seems borne out by more recent information. However, there is one caveat: Particular circumstances, as in the TVA example above, may cause atypical and undesirable shifts.

Staggered Work Hours. The state of Hawaii, as a demonstration project to determine whether spreading arrival times of downtown workers would relieve peak-period congestion, changed official office hours for state, city, and county employees from 7:45 AM–4:30 PM to 8:30 AM–5:15 PM for a test period covering February 22 through March 18, 1988. Private sector participation was encouraged but not required. About one-half of all public sector employees shifted their work hours to the prescribed later schedule, while only 8.4 percent of private employees shifted schedule (Giuliano, 1992).

The net effect was that about 4,000 workers, or 6 to 7 percent of the downtown workforce, participated in the project. The shift in start times was judged to have had a significant positive effect on traffic conditions. Average estimated time savings for commuters were 3 to 4 minutes, or 7 to 9 percent of the average 45-minute commute time. Travel-time savings differed by route and time of day. The project did spread out peak travel, which improved conditions for those traveling during the most-congested time periods, but made conditions slightly worse for those already traveling during the less-congested time periods.

Most project participants experienced little or no significant change in travel conditions during the project, with some important exceptions. Participants from the most distant suburbs who had previously worked the 7:45 AM–4:30 PM schedule saved 9 to 15 minutes (15 to 25 percent), while those

[10] The percents reported here are not percentage point changes but are relative percentage shifts.

who had been starting work prior to 7:30 AM experienced *increased* travel time of up to 10 minutes (30 percent relative to their originally shorter travel times). Demographic characteristics of participants and non-participants were quite different. Non-participants had more children, used child care services, were younger, and a higher percentage were female. Participants were more likely to be in professional or technical occupations and to be from households with fewer numbers of workers. Participants were also more likely to be car drivers, and reported more problems with time pressures or schedule constraints (Giuliano, 1992).

Flexible and Staggered Hours Employee Involvement. An important consideration in any variable work hours program, be it flexible/staggered work hours or CWW, is that a sufficiently high percentage of the employment base needs to participate in the program. If peak-spreading and congestion reduction are the primary objectives (as opposed to mode shifts and vehicle trip reduction), then enough employees must be involved in order to have a tangible effect on total travel volumes.

In Ottawa, for example, where the Canadian government is the dominant employer, it was possible to include almost all government workers—and thus almost 50 percent of the central area workforce—in a variable work hours program. Peak hour to peak period ratios for transit rider loads were reduced by 8 to 19 percent at the downtown Ottawa cordon and even more as measured at the workplace (Safavian and McLean, 1975). (See "Site- Versus System-Level Impacts" under "Related Information and Impacts" for additional detail on Ottawa highway and transit impacts.) About 100,000 out of some 480,000 Lower Manhattan employees eventually became involved in a program jointly sponsored by the Port Authority of New York/New Jersey and the Downtown-Lower Manhattan Association. Transit passenger counts at key subway stations were lowered by 18 to 26 percent (O'Malley and Selinger, 1973). (See the case study "Staggered Work Hours in Manhattan—New York, New York" for more.) Thanks to U.S. federal government support, circa 1980 variable work hours programs in Washington, DC, and Denver likewise involved substantial portions of both the federal, as well as the overall, employment base (Pratt and Copple, 1981).

Given a choice, uninitiated employers—at least prior to more experience with flextime—have preferred the concept of staggered hours to flexible hours, since flexible hours puts considerably more discretion in the hands of the individual employees, making the number of employees who will show up at any given time less certain. However, evidence from the 1970s experiments in Manhattan and San Francisco suggested that employees on flexible hours do tend to stagger their own work hours. Between 73 percent and 75 percent of employees involved in those flextime programs reported selecting work arrival and departure times designed to avoid traffic and transit congestion. The trip timing results were comparable to those achieved with typical staggered hours schedules (Pratt and Copple, 1981). It should be noted, however, that certain more recent suburban applications (Bishop Ranch and Pleasanton in California) stand as exceptions.

Compressed Work Week. In the early 1980s, a carefully controlled experiment involving CWW schedules was staged in Denver, involving about 9,000 federal employees in 42 separate agencies. The participation within federal agencies exposed to the program was 65 percent. The most popular schedules were the 9/80 and the 4/40, which resulted in participants arriving at work an hour earlier and departing about an hour later than before. The program was shown to flatten the peak, with the maximum percentage of total arrivals in the peak half hour declining from 56 percent to 42 percent, and the equivalent percentage of departures dropping from 47 percent to 34 percent. Evaluations suggested that the CWW strategy had only small effects on aggregate ridesharing and transit mode shares. Within the aggregate figures, matched data did show that non-participating employees showed decreased ridesharing and increased solo driving and transit use, largely counterbalanced by increased ridesharing by participants. It was inferred that ridesharing arrangements had been disrupted for non-participants, but it was also evident that those electing CWW had been able to form carpools and to do so to a greater degree than before (Atherton, Scheuernstuhl, and Hawkins, 1982; Cambridge Systematics, 1980).

The Denver Federal Employee CWW experiment found, with regard to travel mitigation, that net household VMT reductions for both work and non-work travel together averaged 14 to 15 percent for participating employees. This determination took into account not only commute VMT savings from the 1 or 2 days per week where travel to work was not required, but also household travel effects for the full 7-day week. The strong implication from the Denver evaluations is that CWW allowed more efficient accomplishment of non-work travel objectives, may have discouraged travel on the inherently longer workdays, and did not induce expanded weekend travel. Similarly, no expansion of out-of-area travel and no offsetting of work trip VMT savings were observed in Washington, DC, federal CWW applications (Cambridge Systematics, 1980; Skinner and Shea, 1981; Atherton, Scheuernstuhl, and Hawkins, 1982).

As part of its effort to meet the trip reduction requirements of the Air Pollution Control District's Rule 210 (predecessor to Regulation XV), Ventura County tested a variable work hours program consisting of flextime and both 9/80 and 4/40 work weeks. Commuter Transportation Services, Inc. (CTS) conducted a 6-month pilot project to determine the impact on ridesharing and organizational effectiveness. A total of 367 employees were involved, with 172 adopting a 9/80 schedule, 76 on flex-time, and 33 on a 4/40 schedule. The remaining 86 either did not opt for one of the variable work hours offerings or chose to discontinue participation somewhere in the 6-month program.

Survey information revealed that drive-alone rates in the sample of 367 declined from 82.2 percent to 76.6 percent over the course of the project, while ridesharing rates increased from 8.0 percent to 12.8 percent, and use of "other" methods increased from 9.8 percent to 10.6 percent. While the CTS evaluation also determined that commute time decreased for persons participating in one of the variable work hours programs, the actual amount of time saved was not determined, nor was a link drawn between the specific variable work hours program and the pattern of mode shifts. The time savings was believed to be related to shifting out of peak period traffic and possibly also to the ability of ridesharing participants to use carpool lanes (Freas and Anderson, 1991).

A 1995 study of the effects of CWW on employee travel by the California Air Resources Board found that 2,600 Southern California employees on CWW schedules reduced their net number of trips by an average of 0.5 per week. Those employees working a 9/80 schedule drove an average of 13 fewer miles per week, while those working a 4/40 schedule drove an average of 20 fewer miles per week (Association for Commuter Transportation et al., 2004).

Analysis of Washington State CTR Program data indicates that employee participation in CWW schedules at CTR-covered employers grew steadily from 14.5 percent in 1993 to 20.0 percent in 2005. The 2005 rate was in a context where roughly 2/3 of CTR Program employees were apparently eligible to choose CWW. Participation in 9/80 schedules doubled between 1993 and 2005, to 5.8 percent. Participation in 4/40 schedules grew more slowly, but still remained most prevalent at 7.3 percent. The 3/36 variation, common in health care facilities, attracted 2.3 percent of employees covered by the CTR program in 2005, with a health care worker participation rate of 33.6 percent. A related notable statistic was the craft/production/labor employee CWW participation rate of around 24 percent, actually a shade higher than the rate for professional/technical employees (Zhou and Winters, 2008). More information on relationships between CWW involvement and worker characteristics is found in the upcoming "Underlying Traveler Response Factors" section, under "Individual Behavioral and Awareness Considerations"—"Alternative Work Arrangements Considerations."

Telecommuting. A 1992 national telecommuting survey obtained information on telecommuting behavior from 16 organizations representing almost 5,000 telecommuters. The organizations consisted primarily of government agencies (13) and telecommunications companies (2). One of the 16 was a telework center. While the overall size of these organizations is not known, the number of telecommuters ranged from seven to 2,600, with a mean of 310 and a median number of participants of 82. The great majority of employees taking part in these telecommute programs were found to be in professional (61 percent) or managerial (23 percent) occupations, with clerical and data entry (14 percent) and other classes of employees (2 percent) making up the remainder (Rathbone, 1992). (More information on telecommuter demographics, job types, and workplace characteristics is found in the above-mentioned "Individual Behavioral and Awareness Considerations" discussion.)

The most common telecommute schedule found in the 1992 survey was 1 day per week, representing 55 to 59 percent of the sample (depending on interpretation), followed by 18 percent who telecommuted 2 days per week. On the other hand, 12 percent were found to telecommute 5 days per week. The organization with 2,600 participants, a county government, reported telecommuting frequency distributions of 5 days per week (1 percent), 4.5 days (6 percent), 3 days (14 percent), 2 days (53 percent), 1 day (8 percent), 1 day per 2 weeks (13 percent), and 1 day or so per month (5 percent) (Rathbone, 1992), for an average of 1.96 days per week. Most of the 16 organizations surveyed reported telecommuting rates that average 1 to 2.3 days per week. The 2 outliers are the telework center with 24 participants averaging 4.8 days a week and a transit agency with 10 clerical workers telecommuting 5 days a week (clearly a telephone service-information operation). The average for the overall sample is 1.8 days per week and the median is 1.6.

It is important to note that only a fraction of responding organizations in the 1992 survey reported telecommuting at frequencies of less than 1 day per week, creating some ambiguity. A 2002 Southern California Association of Governments (SCAG) home-based survey of about 5,000 Southern California residents does fully address infrequent telecommuting, having first identified persons in the workforce, and then the telecommuters among them, and finally those who telecommuted in the previous week. A strict definition of telecommuting was utilized, eliminating home-based-business workers and overtime home-workers. Out of 2,766 workers, 24.6 percent were employees reporting at least 1 day of teleworking in the last 2 months, 7.0 percent were home-based-business workers, and 68.4 percent were non-teleworking employees. Table 19-19 provides a telecommuting frequency analysis derived using a final frequency analysis sample of 499 telecommuters (Walls, Safirova, and Jiang, 2007).

Table 19-19 Telecommuting Frequency Analysis of 2002 Southern California Workers Telecommuting at Least Once in Two Months

Days Telecommuted in the Previous Week	Number of Telecommuters	As a Percentage of Telecommuters	As a Pct. of Workers Telecommuting in the Previous Week
0	258	52%	—
1	54	11%	22%
2	45	9%	19%
3	27	5%	11%
4	18	4%	8%
5	97	19%	40%
Subtotal telecommuting in previous week	241	48%	100%
Total telecommuting in previous 2 months	499	100%	—

Source: Derived from Walls, Safirova, and Jiang (2007).

From Table 19-19 it may be calculated that workers who had telecommuted the previous week averaged 3.2 days per week of telecommuting. If one makes an assumption that the remaining telecommuters averaged 0.25 telecommutes per week, then the average per week for all persons in the telecommuter sample was 1.7 telecommutes per week. Applying this all-telecommuter rate back to the full sample suggests an all-worker rate of 0.4 telecommutes per week for the 2002 Southern California working population as a whole.

There are contemporary estimates of telecommuting that may appear to be, but are not necessarily, higher. For example, it has been concluded that data collected in national workplace surveys suggest that "the incidence of work at home at least one day per week ranges from 8.9 percent of all employed persons in Ireland to 11.1 in the UK and 15 percent in the US" (J. H. Pratt as quoted in Lyons, Farag, and Haddad, 2008). From the SCAG survey findings for telecommuters, it may be computed that 12 percent of Southern California employees telecommute at least 1 day per week (48 percent of 24.6 percent). However, since the quoted international comparison appears to include home-based-business workers and may even include overtime home-workers, which the SCAG analysis does not, the Southern California rate is most likely highest when placed on equal footing.

A definitively higher estimate of telecommuting comes from Washington State, although this estimate is based on surveys limited to firms in the state's CTR program (generally firms of over 100 employees). In 2007, telecommuting displaced about 2 percent of commute trips among the covered firms. Periodic surveys have showed a slow but steady increase in telecommuting (Hillsman, 2009). Quite possibly increasing gasoline prices were a factor up through the latest available survey dates. Increases in telecommuting have also been reported from the United Kingdom, which lags a little behind the United States in adoption (Lyons, Farag, and Haddad, 2008).

Turning to observed commuter response to telecommuting, there are several demonstration programs of interest. Beginning in 1990, the Washington State Energy Office staged a 2-year Telecommuting Demonstration project in the Puget Sound area involving 25 public and private organizations and 280 participants. In structuring the monitoring and evaluation of the experiment, the researchers obtained information through surveys, travel logs, and related media using four groups of people: telecommuters, their supervisors and co-workers, and a comparison group. Most of the telecommuters were home-based, but 24 individuals from nine organizations used the Energy Office's new State Telework Center. Pre-program surveys revealed that 61 percent of the telecommuters previously drove alone to work, 18 percent used carpools, 17 percent used transit, and the remainder walked, biked, or were dropped off. The comparison group was similar, but with lower use of carpools (12 percent). These proportions did not change significantly over the demonstration, with 63 percent of telecommuters and 64 percent of the controls reporting drive alone as their usual method of reaching work. Average commute trip length for telecommuters was 18 miles, compared to 8 miles for the comparison group and 10 miles on average in the Puget Sound region, suggesting that telecommuting is particularly attractive to employees living a long distance from work.

The survey data indicated that by the end of the demonstration, telecommuters had reduced their total commute trips by about 26 trips per year, while members of the comparison group reduced their trips by 10 per year, primarily as a result of shifts in mode motivated by the employers' commute assistance programs. A travel log analysis revealed that telecommuters were saving trips and miles traveled on their telecommute day, and not making up for lost trips on their non-telecommute days. Before the program began, the telecommute participants made 4.3 trips per day, corresponding to 52 miles in 101 minutes. One year later, they made 2.6 trips per day on telecommute days, traveling 13 miles in 35 minutes, and on non-telecommute days made 3.9 trips, going 49 miles in 91 minutes. Sample size limitations prevented an analysis of use by other household members of the telecommuter's car on telecommuting days. Telecommuting was estimated to have reduced average commute VMT per telecommuter on telecommute days by 36 miles, netting out to 29 miles after accounting for mode shifts.

In the special case of the telework center, travel data indicated that vehicle trips did not decrease for these participants, since they still had to commute to the center. Furthermore, while only 56 percent of these telecommuters drove alone to the main work site, 83 percent drove alone to the telework center (Washington State Energy Office, 1992).

A Southern California telecommuting test among SCAG employees in 1988 showed a reduction in person trip miles as a result of work trips avoided and shorter trips to telework satellite centers. The average net person trip distance reduction was 46 miles for each telecommute occasion. Allowing for the usual mode of travel for telecommuters—accounting for the fact that some normally used transit or carpool—31 vehicle miles of travel were saved per telecommute. Fourteen percent of SCAG's employees participated in the experiment, with average participation being once every 9 days. Most worked from home, and one worked at a satellite work center. The SCAG experiment showed some increase in non-work trips due to telecommuting. It was estimated that VMT "created" as a result of working at home amounted to 14 percent of the miles saved; therefore, the net savings in VMT per telecommute was 26 miles, not 31 (SCAG, 1988).

The state of California also conducted a pilot telecommuting project in the late 1980s, involving over 400 state employees across 13 agencies (both participants and non-participating "controls"). The findings suggested that physical trips to work by telecommuters decreased by 30 percent, from 0.90 to 0.63 trips per day, compared with non-telecommuters whose rates did not change. Those participating were found to telecommute 1 to 2 days per week. Preliminary findings showed no increase in non-work trips by telecommuters, but instead found a reduction in non-work trips for other household members. Non-work person trips fell by 35 percent, from 3.6 to 2.3 per day (Kitamura et al., 1990).

In Hawaii, the state department of transportation conducted a satellite telecommute demonstration project in which it established a telework center in Mililani, Oahu, located 20 miles from downtown Honolulu. Seventeen employees participated in the demonstration (seven public sector and 10 private sector). An evaluation found that 93 percent of the employees experienced a reduction in number of work trips and an average drop in fuel consumption of 29 percent. Travel time savings averaged 7.4 hours per week (Giuliano, 1992).

An important 1990s synthesis-type study on telecommuting aimed at providing a framework for more accurately estimating the travel benefits associated with telecommuting. A model proposed on the basis of this synthesis accounts for two essential factors when attempting to estimate telecommute VMT savings:

1. Determining the amount of telecommuting that occurs on a given day.

2. Determining the actual vehicle miles of travel avoided as a result of a telecommute event.

In addressing the first factor, cross-sectional data from various telecommute programs (including Puget Sound and the state of California) were used to conclude that about 16 percent of all employees are in a type of occupation where they can reasonably telecommute, that 50 percent of these will want to telecommute, 76 percent of these will actually participate, and—based on an average frequency of 1.2 days per week—about 24 percent will telecommute on a given day. When these proportions are jointly accounted for, the model projects that about 1.5 percent of the workforce could and would telecommute on a given day (Mokhtarian, 1998).

In terms of the second factor, telecommute day VMT reduction, the study points out that not every telecommute event results in a VMT reduction equal to the commute trip length. The reasons are that not all of these trips are otherwise made as drive-alone, that some workers actually drive in to the worksite for all or part of their telecommute day, and that there may also be an increase in non-work trips taken that day. The analysis estimates that about 82 percent of telecommuters normally drive alone—compared to a national average for all commuters of 73.2 percent in 1990—and that about 6 percent will actually commute on the telecommute day. These estimates suggest that a telecommute day only eliminates a vehicle trip 76 percent of the time (82 percent drive alone less 6 percent actually commuting). When taken together with the proportion of the workforce that would telecommute on a given day, the evaluation framework estimates that the average daily VMT reduction per employee achievable with a (regional) telecommuting program would be 0.5 miles on an average round trip by SOV of 43 miles, or roughly 1 percent.

In light of these calculations, the researcher concludes that it would be unlikely that a TDM program based purely on telecommuting would ever reduce travel sufficiently to obviate the need for new transportation capacity. Also, if certain assumptions are made in the model with regard to residential relocation or induced demand enabled by telecommuting, the travel stimulation effects could equal or exceed the VMT reductions from telecommuting (Mokhtarian, 1998).

UNDERLYING TRAVELER RESPONSE FACTORS

The travel response of commuters to TDM initiatives involves many of the same underlying individual behavioral and decision processes found to influence response to most types of transportation system changes. In the case of TDM, however, there are more layers of factors involved. Some are fairly unique to TDM. The environment is relatively atypical as well. While individual commuter response to TDM in part involves normal travel choice and decisionmaking functions, the context is one where peer (or supervisor) influences and corporate culture may be uniquely important. The "changes" involved—produced by the TDM strategies themselves—are dependent on choices by the employer or institution. Employee awareness of travel options can also be significantly affected by the organization.

These managerial outcomes in turn will have been influenced by the needs being addressed by the TDM program and the laws and regulations involved (or not involved). Overall effectiveness will be a function of not only employee participation and response, but also the precursor employer participation and response. This section, along with additional topics in the "Related Information and Impacts" section, seeks to illuminate key aspects of these underlying influences on how TDM programs are likely to be implemented and how effectively they will influence travel decisions.

Individual Behavioral and Awareness Considerations

As alluded to previously, a commuter's travel response to TDM programs represents a complex intermixture of individual behavior presumed to conform with established travel demand theory plus less-well-understood interactions with workplace dynamics. Lifestyle and life cycle impacts also seem to be more evident than in the response to more conventional transportation system changes, either because they are in fact more important in the case of responses to TDM or perhaps because they simply have received more attention given the shorter-term focus and more individualized nature of TDM actions. This subsection starts with examining the role of tripmaker economic utility decisions and then proceeds through other layers of influences including barrier effects, interactions of the employer and employee, special considerations involved in alternative work arrangements, and employee awareness of available program elements.

Time, Cost, Convenience, and Barrier Effects

Travel demand theory suggests that travelers' choice of travel mode is heavily tied to the comparative economic utility among the alternatives. This utility is most commonly expressed in terms of travel time, travel cost, and certain measures of convenience. In this paradigm, travelers see additional travel time, cost, or inconvenience as a "disutility," and make their choices in such a manner as to minimize this disutility.

In the majority of cases facing commuters nationwide, the private automobile offers the lowest disutility. This is because its users have little difficulty accessing it at the beginning of the trip, generally pay no direct cost to use public roadways, and in most cases can park for free or at a substantial discount at the employment site. These advantages are particularly evident for commute trips beginning or ending in suburban areas. With such advantages, along with the convenience of being able to define one's own schedule of departure and arrival, it is little surprise that the majority of commuters opt to use their private vehicle. The alternative commute modes involve the effort and time constraints of participating in a carpool or vanpool, or taking the time to travel by walking or bicycling, or having to drive or walk to a transit line where there may be a wait for the vehicle to arrive—with potentially no unoccupied seat and certainly requiring payment of an often substantial fare. The situation is not helped by the fact that, once in the carpool, vanpool, or transit vehicle, the commuter is most often stuck in the same traffic congestion as the private car, minimizing any apparent advantage to switching modes. There are also related barrier effects where, for example, use of transit may not be feasible because of lack of a connection or service at the needed time.

One thing TDM must do in order to be effective is to change the equation by making the alternative modes more attractive in terms of relative time, cost, and convenience and by addressing related barrier effects. Preferential closer-in parking for carpools and vanpools, and contract transit service enhancements that lessen wait for a bus, are examples of strategies with elements of time saving and enhancement of convenience.

Straightforward incentives and disincentives directly address the cost component of the utility equation. Transit, vanpool, carpool, and walk/bike subsidies provide monetary savings to the employee through choice of the covered alternative commute modes. Parking pricing impacts the cost equation by enhancing the out-of-pocket cost advantage of alternative modes. The companion strategy (or phenomenon, as the case may be) of restricted parking supply makes driving and parking less convenient and more time-consuming by increasing uncertainty about space availability and often lengthening the walk from parking to the workplace.

Commute mode choice response to travel time, cost, and certain convenience changes introduced by TDM actions may be anticipated using travel demand model relationships. Table 19-20 lists key mode choice model coefficients averaged across 1990–2002 modeling results from 26 urban areas across the United States. Ranges are also provided. These coefficients were assembled as part of an update to EPA's COMMUTER model (U.S. Environmental Protection Agency, 2005), outlined in the "Additional Resources" section.

Each average coefficient in Table 19-20 is paired with commentary as to what it signifies with regard to how commuters weigh time, cost, and convenience factors in mode choice travel decisions. Convenience factors are implicit in the "Out-of-Vehicle" times: Walking implies something less than doorstep service, and waiting implies less than continuously or immediately available service. The higher these out-of-vehicle time values are the more inconvenience is implied.

Table 19-20 United States 1990–2002 Mode Choice Model Coefficients with Interpretation

Time or Cost Variable	Average Coefficient	Coefficient Range	Interpretation of the Average Coefficients
In-Vehicle Time (minutes)	-0.0253	-0.0113 to -0.0450	(In-vehicle time is the time spent driving, or riding in a car, vanpool, or transit vehicle.)
Walk (Out-of-Veh.) Time (min.)	-0.0473	-0.0186 to -0.0931	Time that must be spent walking is roughly twice the disincentive as time spent in-vehicle.
Transit Wait (Out-of-Veh.) Time (min.)	-0.0466	-0.0155 to -0.0978	Wait time (1/2 the time between transit vehicles) is also about twice as onerous as in-vehicle time.
Auto Commuter Parking Cost (cents)	-0.0056	-0.0004 to -0.0173	One minute of in-vehicle-time is as important as 4.5¢ of parking cost ($2.70/hour value of time).
Transit Fare (cents)	-0.0040	-0.0004 to -0.0135	Dollar per dollar, transit fares are somewhat less onerous (less of a disincentive) than parking cost.

Notes: The coefficient ranges exclude certain values deemed by the researchers to be outliers.

The researchers report historic guidelines that conflict somewhat with certain interpretations provided in this table, most notably, that 1 minute of in-vehicle-time is only as important as 3 cents of parking cost ($1.80/hour value of time).

Source: U.S. Environmental Protection Agency (2005), with certain interpretations by the Handbook authors.

Barriers to the use of alternative commute modes are not amenable to incorporation as continuous variables in a forecasting relationship—they are more in the "go"/"no go" realm of cause and effect. Barriers are addressed by such actions as contracting to bring transit service to an otherwise unserved employment site. Shuttles connecting suburban worksites with outlying rail transit stations eliminate a barrier to employee use of time-competitive rapid transit or commuter rail services. Lockers and changing facilities address a barrier to active transportation—walking, jogging, or bicycling—by providing a place to freshen up and change out of athletic gear or informal clothing prior to reporting to work. Circulator shuttles or availability of company cars addresses the perceived or actual need for a car during the day for errands or company business, making use of any alternative commuting mode more tractable.

Need to drive alone in order to run errands or meet other family needs, such as childcare drop-offs and pickups en route to or from work, is a barrier effect similar to the need for having one's own car at hand during the day. En route satisfaction of travel needs is a phenomenon addressed at the end of the "Underlying Traveler Response Factors" section, in the "Trip Chaining" subsection. A travel demand modeling effort to include both time, cost, and convenience factors on the one hand, and barrier (and other) effects on the other hand, is described in the "Related Information and Impacts" section under "Modeling Studies"—"California Air Resources Board Survey and TDM Program."

Facilitation and Encouragement

Alternative mode use may involve new ways of doing things for the employee that are, or at least seem to be, complex. For example, formation of a vanpool is not a simple endeavor for the uninitiated. Even forming a carpool requires hard-to-obtain information on who is commuting in about the same direction at about the same time. In addition, vanpool and carpool formation and continuation involves interpersonal influences that may include possible reluctance to travel with strangers or to assume a lead role in organizing rideshare arrangements. These concerns and also uncertainty as to the risks and responsibilities involved are thought to be major obstacles to ridesharing (Pratt and Copple, 1981).

Help and encouragement in crossing these thresholds, in the example of vanpooling, is the function of vanpool formation and cost sharing assistance. Such programs provide facilitation through varying degrees of employer involvement in vehicle purchasing or leasing, underwriting of insurance and maintenance costs, or possibly providing and maintaining the vehicles themselves or arranging with another entity to do the same.

For encouraging use of the broader array of alternative transportation choices, transportation coordinator support, on-site transit information and pass sales, and rideshare matching services all serve to overcome the information barriers, discomfort, and uncertainty associated with forming group travel arrangements or taking the leap to become a transit or walk/bike commuter. Indeed, the whole array of "Support Action" strategies, addressed at the beginning of the "Response by Type of TDM Strategy" section, are focused on facilitation and encouragement.

The fear of being stranded at work in an emergency or because of unscheduled overtime is still another barrier. Guaranteed ride home is the strategy geared to addressing situations where alternative modes can't themselves meet such off-schedule needs.

A factor that has characterized a number of the most successful worksite TDM programs, but is very hard to propagate on a multi-employer basis, is a deeply supportive company culture. One of the best examples comes from the 1970s and 1980s in the form of a program with heavy vanpool emphasis, that of the Minnesota Mining & Manufacturing Co. (3M) in St. Paul. During this period the 3M vanpooling program attracted usage that recognized rules of thumb suggest should be improbable. It is hypothesized that the program may have been operating in a "supersaturated" mode in response to not only the 1970s energy crises but also a very special corporate enthusiasm and ethic. For a full discussion of this example, see Chapter 5, "Vanpools and Buspools," under "Response to Vanpool and Buspool Programs"—"Employer Sponsored Vanpool Programs"—"Outstanding Employer Vanpool Programs."

Alternative Work Arrangements Considerations

Variable work hours arrangements are somewhat unique among TDM strategies in that the trip timing decision process of the individual employee comes into full play when employees are given the discretion to choose their own work times, as with flextime. This decision process involves trade-offs among at least partially conflicting factors. A survey of California State Automobile Association (CSAA) employees early in the development of discretionary alternative work arrangements found four causal factors to be particularly important. These considerations were occupational factors (deemed important by 81 percent of surveyed employees), travel congestion effects (75 percent), social/family responsibilities (71 percent), and issues related to the use of alternative modes (92 to 36 percent depending on mode).

Occupational factors relate to employee matching of work hours to the needs of the office, which include work coverage requirements such as receptionist duties. Congestion effects relate to desired avoidance of rush hour conditions in order to shorten travel times or minimize the discomfort of crowding. Social/family responsibilities include the desire to spend more productive time at home with friends and family, and such responsibilities as seeing that children get to school or day care. Modal usage factors encompass the trip coordination required to participate in vanpools and carpools (increasingly important with increasing numbers of passengers) and to match transit schedules (50 percent responding important in the CSAA interviews) (Harrison, Jones, and Jovanis, 1979; Jovanis and May, 1979).

Modal usage factors would vary by location—the CSAA offices were in downtown San Francisco—and occupational factors would obviously vary in response to employer requirements. The interplay and relative importance of factors influencing changes in travel mode in conjunction with work time shifts have been difficult to research. Outcomes in relation to individual categories of employer and institutional TDM strategy have been examined in each subsection of the preceding "Response by Type of TDM Strategy" section.

Compressed work week (CWW) options introduce another dimension of travel pattern effects. They bring the opportunity and/or necessity for major non-work travel adjustments. Evidence from the federal employee experimental programs indicates that travel on the weekday off typically consists of urban trip tours of linked trips to multiple destinations, like normal Saturday travel, with trip purposes similar to the usual weekday non-work trips. Extension of weekday work trips to include intermediate linked-trip destinations becomes less common, either because non-work travel needs are met on the weekday off, or because the workday simply becomes too long for much detouring. Previous weekend travel may also be shifted to the weekday off (Cambridge Systematics, 1980; Skinner and Shea, 1981).

Regression analysis of CWW schedule participation among workers under the Washington State Commute Trip Reduction (CTR) program suggests that CWW is more attractive for employees with supportive employers, long commutes, and multi-modal commutes such as drive to transit. CWW participation is less among single-mode transit and shared-ride commuters. Work in manufacturing and health care industries, along with government, was found to be a positive indicator for CWW choice. Work in information service/software was found to be negative for CWW, along with jobs involving management and administration (Zhou and Winters, 2008).

As will be seen, the employment-related positive/negative indicators for CWW participation have major differences compared to telecommuting. Indeed, few manufacturing firms are typically found among any other forms of TDM involvement. CWW appears to work well (quite likely in non-optional applications) for industries where workers must be present at their jobs, on a regular schedule. It thus may fill an important gap in the spectrum of TDM strategies. With regard to the lesser CWW participation among single-mode transit and shared-ride commuters, it is not clear if such commuters feel less urgency to work fewer days, prefer regular hours to support their choice of mode, or are more likely to give up on single-mode transit and shared-ride commuting.

Telecommuting adds even more decision dimensions, because it involves an actual shift in work location away from company facilities to the home or sometimes a telework center. Examination of telecommuter trip characteristics, demographics, job types, and characteristics of their employers, along with other information, provides a basis to make inferences about factors affecting telecommuting. The following information summarization is drawn from the literature reviews and modeling efforts of two California studies, one utilizing the 2002 home-based Southern California Association of Governments (SCAG) survey (Walls, Safirova, and Jiang, 2007) and the other a survey of residents in eight Northern California neighborhoods (Tang, Mokhtarian, and Handy, 2007):

- Longer commute trip distance and time are positive indicators for telecommuting adoption. (One reviewed study found the converse, but may have included home-based-business workers, with their trip distance of zero.) Modeling success using the square of distance suggests a heightening of positive impact for particularly long commute trips.

- Pay parking at the workplace is a positive indicator, as is the opportunity to make more money as a telecommuter. An increase in work-related costs and substantive technology requirements are negative indicators, as is reduced salary. Both the trip distance/time finding and these cost/income findings demonstrate once again the importance of time and money in commuting decisions.

- Findings are very mixed for the effect of gender. One reviewed study suggests, based on Montreal data, that the key relationship is one of more empowerment in the workplace being a positive indicator for telecommuting. Where women have less workplace responsibility and freedom of choice, the telecommuting rates tend to be higher for men relative to women.

- Presence of more than one adult in the household is a positive, but findings are very mixed for presence of children. If anything, children under 6 are a neutral or positive indicator, while older children (along with household distractions) are a neutral or negative indicator. Reported results are split between health limitations not being a factor and situations of disability or parental leave being a positive indicator for telecommuting.

- High incomes and a college education, along with other highly correlated factors such as age, are all broadly-reported strong positive indicators for telecommuting adoption—as is intensive and proficient use of computers.

- Work in architecture, engineering, other professions, education and training, sales, and senior or middle management are all positive indicators. Employment in the arts and entertainment, consulting, finance, insurance, and real-estate industries is likewise a positive indicator for telecommuting adoption.

- Work in health care, construction, maintenance, and production, along with employment in the transportation, communication, and retail trade industries are negative indicators. A distinction needs to be drawn between retail trade and sales, as the latter frequently involves home and business visits and is thus often conducive to telecommuting.

- Results are mixed for part-time work as an indicator. Being a contract or self-employed worker is a positive while being a full-time regular employee is a negative indicator.

- As might be expected, job suitability for telecommuting is a positive indicator, whereas the converse is a negative indicator, along with workplace misunderstanding and lack of manager support. Individual perception of a need for office discipline or desirability of face-to-face-communication or social interaction with co-workers is a negative indicator.

- Being a driver or driving to work is a positive indicator, along with perceiving the commute to be stressful. The influence of transit use or availability is mixed.

- Orientation to the family, desire for lifestyle quality improvement, enjoyment of walking, and preference for appealing outdoor landscapes are all positive attitudinal indicators for telecommuting adoption. A non-rural residential location and preference for regional accessibility tend to be negatives.

A potentially quite important finding from the SCAG survey modeling analysis is that employment in an organization with 25 to 249 employees is a negative indicator for telecommuting. The researchers hypothesize that the firms of under 25 employees offer a flexibility conducive to telecommuting, while firms of 250 and more employees are likely to have an established telecommuting program. Mid-size firms are thought not to offer either benefit, being too big for responsive flexibility and too small to support formal programs (Walls, Safirova, and Jiang, 2007).

Both of the California studies also looked at indicators of telecommuting frequency, as distinct from telecommuting adoption. Together, the literature reviewed and the studies' original research suggest that many but not all of the same factors apply, certainly not always in similar degree, but generally in the same positive/negative relationships. Both studies in their own modeling efforts encountered more analysis difficulties with frequency than adoption (Walls, Safirova, and Jiang, 2007; Tang, Mokhtarian, and Handy, 2007). The eight-neighborhood Northern California study concluded that each of three different degrees of telecommuting frequency were associated with significantly different needs and desires (Tang, Mokhtarian, and Handy, 2007). The SCAG-survey-based analysis, in the context of having added a telecommuting program variable to the frequency formulation, found employer size not to be of importance to frequency. However, employees of firms with formal telecommuting programs were found to be 22 percent more likely to be high-frequency telecommuters (4 or 5 days a week) than others (Walls, Safirova, and Jiang, 2007).

Awareness and Comprehension of Options

Whatever influence the utility and characteristics of alternative commute modes have on commute mode choice is dependent on employee awareness and comprehension of the available options and support programs. In the previously mentioned 1993 study for the California Air Resources Board (CARB), a survey of 45 employers engaged in TDM programs in the Los Angeles and Sacramento areas found that a surprising percentage of the employees were unaware that their employer offered a particular type of TDM strategy. Because employees were asked to identify particular TDM incentives made available by their employer, it was possible to compare this knowledge with a listing of the actual incentives supplied by the employer. From this comparison, level of employee awareness was calculated as the number of employees reporting that an incentive was available, divided by the number of employees who actually had the incentive available according to their employers. Employees whose employer did not report providing a particular incentive were not included in the computation. Table 19-21 shows how these awareness levels were found to vary across the different types of strategies.

Table 19-21 Average Levels of Employee Awareness of Offered TDM Strategies in Los Angeles and Sacramento Programs

TDM Strategy	Percent Awareness[a]	TDM Strategy	Percent Awareness[a]
Bike Racks	55%	Company Vanpool Vehicles	67%
Showers, Lockers, Changing Facilities	38	Guaranteed Ride Home	36
		Rideshare Matching	70
Bus Pass Discount	17	Rideshare Prizes	64
Bus Pass Sales On-Site	41	Transportation Coordinator	45
Carpool Preferential Parking	77	Transportation Fairs	15

Note: [a] Calculated as the number of employees who reported having each strategy, divided by the number of employees whose employer reported providing the strategy. Each calculation excludes employees whose employer did not report providing the measure.

Source: Comsis (1993a).

While two-thirds of employees were aware of employer-offered measures such as preferential parking and rideshare matching, awareness of certain other measures like transportation fairs and bus pass discounts was below one-fifth of employees. The findings were a revelation to all concerned, and argued strongly for more aggressive information and marketing efforts by the programs. The study concluded that annual TDM marketing plus administrative cost per employee offered the best explanation for variations in awareness. The implication of this relationship is that higher levels of marketing, outreach, and information exchange lead to better informed employees capable of more conscious transportation choices, which in turn translates to the TDM strategies having greater use and impact (Comsis, 1993a). The research effort in question is further described under "Related Information and Impacts"—"Modeling Studies"—"California Air Resources Board Survey and TDM Program."

Voluntary Versus Regulatory Employer Motivation

To appreciate the full array of factors underlying employer and institutional TDM effectiveness, it is essential to recognize that degree of employee motivation is in large measure a function of employer motivation. TDM programs are generally motivated by one of two conditions:

- The employer or institution is facing issues with employee transportation, which are either affecting employee morale and retention or are raising the prospect of high costs and increasing resources devoted to employee transportation needs, particularly parking.

- The employer or institution is required under law or regulation to reduce its vehicle trip generation—particularly peak-period vehicle trips—in order to mitigate congestion, vehicle miles of travel (VMT), or emissions, or to forestall the need for new road capacity.

While a regulatory requirement can compel an organization to implement a TDM program, it is the first of these motivations that is most likely to lead to a productive in-house program. If its employees are suffering congestion delay with few existing options, or entailing the expense of driving long distances, the employer or institution has an economic self-interest in its TDM program success. Economic self-interest will also apply if the organization is seeking to avoid a major employee parking provision expense, be it building and maintaining more of its own facilities or subsidizing the cost of employee parking through a third-party provider. There are also other examples where self-interest pertains, such as when the organization needs to expand, but is opposed by neighbors concerned about traffic and pollution impacts.

In the case of a regulatory requirement, the employer or institution is obligated to implement a program of measures that have the objective of reducing its vehicle trip rate to a specified level. There is little doubt that such a requirement will capture the employer's attention regarding its employees' transportation activity, and equally little doubt that the vast majority of employer TDM programs have been initiated under such circumstances. Beyond that, however, the composition and ultimate impact of a program depends on factors that are much more related to the employer or institution, including:

- Whether the organization perceives employee transportation options improvement, trip reduction, and the opportunity to be a good citizen as a clear advantage to its operation or is simply out to meet the letter of the law.

- Whether the employer holds a fear of losing competitive advantage with its peers in attracting and retaining employees.

- Whether the company administration has an understanding of which strategies will have the desired impact.

While a regulatory requirement may force an employer's hand in implementing a TDM program, the actual composition of that program can vary widely. No known employer TDM regulation specifies the exact strategies to be implemented, or penalizes an organization for failing to achieve a trip-reduction goal. Even in the experience of California's Regulation XV—one of the most stringent TDM regulatory programs tried—employers faced only the pressure of having to revamp their plans at the end of an annual or bi-annual review cycle if they failed to achieve their trip reduction targets. Penalties were incurred only for failure to submit a plan, not for failing to achieve targets.

Lacking direction to the contrary, employers who fail to meet trip reduction targets have been found to generally opt for "more" TDM measures in their revamped plans rather than shift to the more influential financial incentive or disincentive measures. In a review of employer performance under Regulation XV for the South Coast Air Quality Management District (SCAQMD), instances were found where employers had introduced literally dozens of measures into their programs in the hopes of finally finding the right combination. However, most often the simplest programs—those with few measures but including monetary incentives and perhaps one or more transportation services—had the most demonstrable impact on travel behavior and vehicle trip reduction (VTR) (Comsis, 1993b).

It is generally difficult to persuade employers or institutions to adopt financial measures, particularly disincentive actions like parking management or pricing, unless they see a clear benefit to their bottom line. Hence, the existence of a regulatory requirement is no guarantee that this class of measures will be widely adopted. The experience gleaned from the 82-program sample reinforces this conclusion, in that while a number of "success stories" may emanate from areas with regulatory requirements, almost as many of the successful examples come from areas where there is no formal motivation beyond economics, concern for employees, or peer pressure.

These conclusions are supported by the data in Table 19-22, which shows the frequency with which particular TDM strategies are applied in regulatory versus voluntary environments. The first two columns characterize the types of strategies offered by employers and institutions in the 82-program sample, in which 59 programs were conceived under regulatory pressures while the remaining 23 were "voluntary" (although this latter group may have experienced tacit pressure from the community or peers to participate). What can be seen in this initial two-column comparison is that, overall, there is not a substantial difference in terms of how frequently many of the strategies appear in TDM programs.

Most regulatory programs have required provision of certain basic measures, especially marketing and promotion, information on alternatives, rideshare matching, an employee transportation coordinator (ETC), guaranteed ride home, bike racks, and preferential carpool parking. In this respect, the regulatory programs do show somewhat higher participation in these strategies. However, for the more material measures, such as pioneering a vanpool program, managing parking, or providing financial incentives, the voluntary programs in the sample have action inclusion rates that are similar—and sometimes superior—to the regulatory programs.

While there is a higher rate of occurrence of parking fees among the regulated employers, in the vast majority of cases—both voluntary and regulatory—the parking fees existed *before* the TDM program was enacted. Almost none of the firms reviewed in the sample explicitly chose to levy parking fees as an integral part of their program. Those that did, such as CH2M Hill and US WEST in Bellevue, Washington, encountered parking fees as a consequence of office relocation, and simply went on to use the fees as a mechanism in their program. Most with pre-existing parking fees altered the structure of those fees, generally to provide cost incentives to carpools and vanpools through High Occupancy Vehicle (HOV) parking discounts, and/or they used the parking revenues to help subsidize other program measures, such as modal subsidies. These pricing strategies, however, were not found to be unique to either regulated or voluntary programs. Indeed, turning from parking pricing to parking availability, the voluntary examples exhibit a slightly greater degree of restricted parking. Constrained parking may help explain the employer's interest in having an effective TDM program.

Strategy-frequency assessments of two specific regulatory programs, those in Los Angeles and Sacramento, are highlighted in the last two columns of Table 19-22. Here a slightly different perspective is seen in the approach to TDM. In particular, the "perfunctory" measures are shown to occur with high frequency, including marketing and information (90 to 100 percent of all employers offering); rideshare matching (84.7 percent in Los Angeles); bike racks, showers, and changing facilities (70.7 to 80.6 percent); and guaranteed ride home (65.5 to 71.8 percent). ETCs were not broken out in these studies, but are specified in the regulations and are probably subsumed in the marketing and information category.

Table 19-22 Relative Frequency of TDM Strategy Offerings in Employer TDM Programs

TDM Strategy	82 Programs[a] "Regulated"	82 Programs[a] "Voluntary"	Los Angeles[b] Regulation XV	Sacramento[c]
Marketing, Information, and Promotions	30.5%	30.1%	90.5%	100.0%
Rideshare Matching	72.9%	65.2%	84.7%	n/a
Employee Transportation Coordinator	64.4%	47.8%	n/a	n/a
Guaranteed Ride Home	67.8%	57.2%	71.8%	65.5%
Preferential Parking	49.1%	39.1%	n/a	62.1%
On-Site Pass Sales	20.3%	30.4%	54.6%	n/a
Bike Racks, Lockers, Showers	52.5%	43.4%	80.6%	70.7%
Vanpool Program	18.6%	39.1%	n/a	n/a
Shuttle/Buspool	49.1%	13.0%	n/a	15.3%
Use of Company Vehicles	11.9%	8.7%	n/a	n/a
Flextime	59.3%	47.8%	29.5%	n/a
Compressed Work Week	44.1%	26.1%	23.3%	70.7%
Telecommuting	18.6%	17.4%	10.2%	23.3%
Transit Subsidies	71.2%	65.2%	48.5%	53.4%
Other Modal Subsidies	47.5%	65.2%	29.8%	21.9%
Parking Cash Out or Transportation Allowance	8.5%	4.3%	0.7%	8.3%
Parking Fees	40.6%	30.4%	6.3%	36.2%
Restricted Parking	45.7%	52.2%	5.8%	22.6%
Sample Size	59	23	4,999	58

Sources: [a] Classified as "regulated" (59 programs) or "voluntary" (23 programs) from the 82-program sample, Appendix Table 19-A.

[b] Young and Luo (1995).

[c] Schreffler (1997).

Transit subsidies were also relatively common offerings in both locations—48.5 percent of all cases in Los Angeles and 53.4 percent in Sacramento—probably because of the tax advantages and the strong statement it makes in the employer's transportation management plan as a legitimate financial incentive. Transit use by commuters in both of these California metropolitan areas is relatively small by national standards, primarily because transit service is not a strong alternative in many locations. Hence, most of the trip reductions have been the result of shifts to carpooling, even though subsidies for modes other than transit were considerably less frequent (21.9 to 29.8 percent). The higher incidence of parking fees in the Sacramento findings compared with Los Angeles is a result of the Sacramento program having been instituted by the city, leading to more focus on employers within the core urban area (Young and Luo, 1995; Schreffler, 1997).

Alternative work schedules are an interesting element in all programs. For the most part, the relatively frequent appearance of flextime in these examples was for the purpose of facilitating alternative mode use, rather than for encouraging travel outside the peak period. Most of the legal requirements studied here did not grant credit for peak shifting. However, most of the regulatory programs did grant trip reduction credit for CWW and telecommuting. One analysis found employers in the Los Angeles Regulation XV environment to have opted for such strategies in later stages of their programs, when the traditional mode shift strategies were not proving sufficient to achieve targets (Comsis, 1994). (Data presented further on in Table 19-27 present a more mixed picture for program Years 1 and 2 in this regard.)

There has been considerable question about the effectiveness of mandatory employer TDM programs, particularly from the standpoint of their regional benefit in reducing congestion or improving air quality in relation to the cost imposed on employers. The issues of air quality and cost-effectiveness are addressed in a subsequent section (see "Energy and Environmental Relationships" and "Cost-Effectiveness" under "Related Information and Impacts"). In terms of net behavior change, however, Table 19-23 provides some insight on the measured impact of the programs on choice of commute method (including both mode and alternative work arrangements). Shown in the table are before-and-after percentage shares obtained from three regulatory programs. The first two are the Los Angeles and Sacramento examples, which were profiled in Table 19-22. The third is taken from Portland, Oregon's Employee Commute Options program, for which equivalent data on adopted TDM measures were not available (TriMet, 2000). In all 3 cases, the averages presented are for employers in the mandatory program only, exclusive of exempted employers.

The Los Angeles program was perhaps the most stringent of the three, requiring employers with 100 or more employees to meet a specified Average Vehicle Ridership (AVR) goal within one year of approval of a trip reduction plan. A rigorous plan approval process was designed to determine whether individual plans were capable of achieving their goal. If they were deemed not sufficient, the employer was persuaded to try new or additional strategies. Employers could be fined for noncompliance, but in virtually all cases where fines were levied, it was for not submitting a plan or for failing to implement strategies that were promised rather than failing to meet an AVR target. Results shown in Table 19-23 for Los Angeles are over a 5-year period, for 4,999 employers that had submitted at least two plans.

In Sacramento, an initial ordinance required employers to reduce peak-period employee single occupant vehicle (SOV) use by 35 percent, and required annual travel surveys and management plans. However, the city attorney's office soon determined that the city could not mandate such a requirement, at which point participation became voluntary. The results shown in the table are for 58 large employers (100 or more employees) participating in the program between 1990 and 1996.

Table 19-23 Shifts in Commute Mode Shares (Percent)—Three Regulatory Programs

Commute Option	Los Angeles[a] (Regulation XV)			City of Sacramento[b] (Employer TSM Ordinance)			Portland, OR[c] (Employee Commute Options Rule)		
	Before (1988)	After (1993)	Pct. Pt. Change	Before (1990)	After (1996)	Pct. Pt. Change	Before	After	Pct. Pt. Change
Drive Alone	73.5%	67.2%	- 6.3%	80.6%	73.0%	- 7.6%	79.5%	74.1%	- 5.4%
Carpool	15.5	21.4	+ 5.9	12.8	17.7	+ 3.9	9.9	9.8	- 0.1
Vanpool	1.2	1.9	+ 0.7	0.5	1.9	+ 1.4			
Transit	4.0	4.3	+ 0.3	2.6	3.5	+ 0.9	7.1	11.1	+ 4.0
Walk/Bike	3.0	3.0	0.0	2.8	3.7	+ 0.9	3.1	2.9	- 0.2
Compressed Work Week	1.3	1.9	+ 0.6	n/a	n/a	n/a	1.3	1.7	+ 0.4
Telecommute	1.4	0.3	- 1.1	0.0	0.3	+ 0.3	0.2	0.5	+ 0.3

Sources: [a] Young and Luo (1995).

[b] Schreffler (1997).

[c] TriMet (2000).

The program in Portland required all employers with 50 or more employees to reduce vehicle trips by 10 percent over 3 years; there were no penalties for non-compliance. The data in Table 19-23 represent 503 employers and 127,000 employees, with a mixture of participation time ranging from 320 sites with only 1 follow-up survey (average of 1.3 years), to 165 sites with two follow-up surveys (average of 2.6 years), and 18 sites with three follow-up surveys (average of 3.9 years).

The overall results in Table 19-23 indicate that each program resulted in a reduction of SOV share of less than 10 percentage points—from a high of 7.6 percent in Sacramento to a low of 5.4 percent in Portland—among the population of large employers. There are interesting differences in how those reductions came about. In Los Angeles and Sacramento, the changes were primarily achieved through a shift to carpool and vanpool, whereas in Portland—with its strong regional focus on its MAX light rail transit (LRT) system and complementary bus services—more of the reductions were the result of shifts to transit. There was little or no change observed in walk or bike use, or in telecommuting, though both Los Angeles and Portland showed above average increases in CWW.

These are, of course, jurisdiction-wide perspectives. A look at one specific district within Portland is provided by the example “Lloyd District Travel Demand Management—Portland, Oregon,” found in the “Case Studies” section. In the Lloyd District, initial shifts were to carpooling, followed by a later overriding shift toward greater transit usage—quite possibly associated with LRT service expansion. Between 1997 and 2005, the employee drive-alone share dropped from 60 percent to 43 percent (Bianco, 2000; Victoria Transport Policy Institute, 2008; TriMet, 2009). Also of interest in assessing the local area potential of mandatory TDM (under favorable circumstances) is the description of central Seattle I-5 corridor CTR program outcomes. This description starts in the “End Results of Dissipation” discussion under “Related Information and Impacts”—“Site- Versus System-Level Impacts” and is taken through the “Cost-Effectiveness” and “Energy and Environmental Relationships” subsections. The CTR program is credited with avoiding, on average, 4 percent more peak-period I-5 ramp traffic and 23 to 44 percent more peak period traffic congestion in the 8.6-mile corridor segment studied (Georggi et al., 2007).

Critics of mandatory TDM as a means of cost-effective, region-wide solution to congestion and air quality problems point to both the relatively small number of employers whose programs have substantial trip reduction impacts and the dilution of these impacts over a large employment base and background regional traffic. A 1993 article written at the height of the regulatory controversy by Kenneth Orski acknowledged that there were compelling examples of substantial modal shifts and trip reductions achieved at individual employment sites, but questioned whether comparable reductions could be achieved at a regional level. He argued, firstly, that work trips constituted only about 25 percent of all daily trips, and were not more than 40 percent of the trips occurring in the peak period. Secondly, he contended that work trips to major employment sites (those with 100 or more employees) constituted only about 40 percent of total work trips, hence about 10 percent of daily trips (16 percent of peak-period trips) and 13 percent of daily VMT would be the maximum affected by a mandatory TDM program. He then calculated that a full 25 percent increase in average vehicle ridership (the theoretical target) would produce a 2 to 3 percent decrease in regional vehicle trips and about a 3 to 4 percent decrease in regional VMT (Orski, 1993).

While such a reduction might prove cost-effective in particular situations, it is well to recognize the relationship between the achievements of a few excellent TDM programs and measurable impact at a regional, corridor, or subarea level. The relationships between individual employer-level results and regional- or facility-level results are further dissected in the above-mentioned "Site- Versus System-Level Impacts" subsection.

Characteristics of Employer

It may be rightly asked whether there is any relationship between the characteristics of the employer or institution staging a TDM program and the types—and thus combined effectiveness—of strategies which are employed. Tables 19-24 and 19-25 explore this question on the basis of two characteristics, type of employer and employer size, once again drawing upon the 82-program sample as described in Appendix Table 19-A.[11] This investigation only attempts to chart the types of strategies which may be more common to particular types of employers, and does not address the implications of these strategy preferences on outcome, namely vehicle trip reduction. Earlier sections have examined the relative effectiveness of various types of strategies versus others.

Many of the conclusions that might be drawn from these displays should be treated with special caution, given the sparse sample sizes for many of the strata. For example, the commercial/service, utility, medical institution, university, and other institution groupings are each represented by less than 10 observations. The samples of employer groupings of fewer than 100 employees, and 500 to 1,000 employees, are represented by only two and seven observations, respectively. Hence, the data should be used only for broadly descriptive purposes.

[11] For an alternative perspective on the mix of strategies offered by employers, focusing on strategy combination information rather than employer type stratification, see the discussion surrounding Table 19-31, "CUTR Worksite Trip Reduction Model—Ranking by Frequency of Occurrence of the 50 Most Common Program Combinations," found in the "Related Information and Impacts" section under "Modeling Studies"—"CUTR Worksite Trip Reduction Model."

With respect to type of employer (Table 19-24), it can be seen that the practice noted earlier of providing basic employer support type strategies—such as offering commute information, rideshare matching, and guaranteed ride home—is widely followed across all of the employment types. It would appear, though, that office, utility, government, universities, and other institutions are somewhat more likely to offer these strategies with high frequency compared to commercial, manufacturing, and medical types of employers. Interestingly, utilities and universities are the most likely to have limited parking and to charge for that parking, while commercial, manufacturing, government, and other institutions are more likely to have ample parking and to provide it without charge.[12]

The offering of preferential parking appears to coincide with the restricted/priced parking that more frequently occurs with utilities, universities, and other institutions, possibly because these are also generally large employers with large parking facilities, where offering close-in parking for HOVs could actually be a meaningful incentive. Consistent with this reasoning, a high percentage of industrial/manufacturing employers (64.3 percent) also offer preferential parking despite the fact that only 14.3 percent report restricted parking capacity. Conversely, medical institutions do not offer preferred parking because, in general, their parking is at such a premium given the multitude of uses (staff, visitors, outpatients) that they have no surplus capacity to part with. (For more insight on the particular circumstances faced by medical institutions, consult Dowling, Feltham, and Wycko, 1991, or the summary provided in this Handbook's Chapter 18, "Parking Management and Supply," under "Response by Type of Strategy"—"On-Street Residential Neighborhood Parking Management"—"Effects on TDM Program Effectiveness").

In terms of transportation service type strategies, particularly vanpool programs, it appears that these occur most frequently among industrial/manufacturing employers, utilities, and universities, in part because of the large sizes and often remote campus locations involved. Transit subsidies are offered at a high rate across the entire set of employers, but have their highest prevalence in professional/office, government, utilities, medical, and other institutions. Provision of modal subsidies other than transit is most prevalent at office, government, and medical institutions.

[12] There is an odd result in the "Other Institution" category where only 28.6 percent have restricted parking but 42.9 percent charge for it. This is not a data error, but rather reflects the policy of the organizations in the sample.

Table 19-24 TDM Strategy Offerings by Type of Employer

TDM Strategy	Prof./Office (25)	Commerc./ Service (8)	Indust./ Manuf. (14)	Govern- ment (10)	Utility (8)	Medical (6)	University (4)	Other Inst. (7)	All (82)
	Percent of Employers Offering Given Strategy by Employer Type (Sample Size in Parentheses)								
Info. Center/ETC	80.0%	50.0%	64.3%	70.0%	87.5%	50.0%	100.0%	100.0%	74.4%
Rideshare Matching	60.0	50.0	64.3	80.0	87.5	50.0	100.0	85.7	68.3
Guaranteed Ride	60.0	62.5	57.1	100.0	37.5	66.7	75.0	57.1	63.4
On-Site Pass Sales	20.0	12.5	21.4	10.0	25.0	0.0	25.0	42.9	19.5
Fairs/Promotions	12.0	12.5	35.7	40.0	0.0	0.0	25.0	57.1	22.0
On-Site Services	8.0	0.0	14.3	10.0	12.5	0.0	0.0	14.3	8.5
Preferential Parking	28.0%	37.5%	64.3%	40.0%	62.5%	16.7%	75.0%	71.4%	45.1%
Bike Racks/Showers	36.0	50.0	50.0	90.0	37.5	33.3	100.0	57.1	51.2
Company Vehicles	12.0	12.5	14.3	20.0	12.5	0.0	0.0	14.3	12.2
Vanpool Program	32.0	12.5	42.9	0.0	37.5	16.7	75.0	0.0	26.8
Transit Services	8.0	12.5	14.3	0.0	0.0	50.0	75.0	14.3	14.6
Restricted Parking	56.0%	25.0%	14.3%	30.0%	87.5%	66.7%	100.0%	28.6%	46.3%
Parking Fees	52.0	25.0	0.0	30.0	62.5	50.0	75.0	42.9	39.0
HOV Parking Discounts	36.0	12.5	0.0	30.0	37.5	16.7	25.0	0.0	22.0
Transit Subsidies	80.0	50.0	35.7	70.0	75.0	83.3	50.0	71.4	65.9
Trnsp. Allow./Cash-Out	12.0	0.0	7.1	40.0	12.5	16.7	0.0	14.3	13.4
Other Mode Subsidies	52.0%	12.5%	42.9%	60.0%	12.5%	66.7%	50.0%	14.3%	41.5%
Other Monetary	12.0	37.5	14.3	20.0	12.5	16.7	0.0	0.0	14.6
Flextime	52.0	75.0	35.7	70.0	87.5	33.3	50.0	57.1	56.1
Staggered Hours	0.0	0.0	7.1	0.0	0.0	33.3	0.0	42.9	7.3
Comp. Work Week	24.0	25.0	28.6	50.0	50.0	66.7	25.0	85.7	39.0
Telecommuting	4.0	0.0	14.3	40.0	12.5	50.0	25.0	42.9	18.3

Sources: Derived (see Appendix Table 19-A) from Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

Finally, with respect to alternative work arrangements, several but not all relationships appear to confirm intuition on the types of employment that are best suited or not suited to these relaxations from a standard 40-hour/5-day work week. For example, government and utilities appear most inclined to offer flextime, while manufacturing and medical institutions do not. Surprisingly, 3/4 of commercial/service employers in the sample offer flextime. Perhaps in-store schedule adherence needs are counterbalanced by order-taking, administrative, and off-site functions. What also seems an anomaly is finding that 1/2 of medical institutions allow telecommuting, despite the critical nature of physical presence at the institution. Other institutions, medical institutions, utilities, and government seem to be the most likely to allow CWW, with a lower but not insubstantial rate of involvement (about 1/4) for office, commercial, manufacturing, and universities. Telecommuting appears at a low rate overall in this sample, more likely to be encountered among government, medical, and other institutions, and less so at office, commercial, manufacturing, utilities, and universities.

Table 19-25 portrays the frequency by which individual TDM strategies are applied in relation to employer/institution size. Unfortunately, uncontrollable irregularities in the distribution of the sample result in too few observations of smaller employers (under 100 employees) and those in the medium-to-large category (500 to 1,000). Limiting the comparison mainly to the 100-to-500 size versus the over-1,000 size employers suggests the following trends: First, those TDM strategies that seem to be offered more frequently by larger employers are rideshare matching; on-site pass sales; transportation fairs and promotions; preferential HOV parking; bike racks and changing facilities; vanpool and supplemental transit programs; parking fees; modal subsidies; other monetary incentives (raffles, prizes, award points, time off with pay); and telecommuting. Strategies where size of employer does not obviously correlate with higher frequency of offering include information center/ETC, guaranteed ride home, use of company vehicles, transit subsidies, HOV parking discounts, flextime, and CWW.

Partially compensating for the lack of information on smaller employers in Table 19-25, Table 19-26 shows the rates at which particular strategies were adopted by employers in their introductory plans for compliance under Regulation XV in Southern California. These data were compiled from SCAQMD's Regulation XV database in a study of TSM Measures in Suburban Settings (JHK & Associates, 1992). The strategies in the table appear in order of the frequency with which they were applied by the largest employers (more than 1,000 employees), although it will be noted that the distribution for the large (500 to 1,000) and medium (100 to 499) size employers is similar in pattern. For the smaller employers, however, the pattern begins to diverge a bit, apparently in relation to the lesser resources of the smaller employers.

A common phenomenon across employers of all sizes is the very infrequent use of parking management, pricing, and direct financial incentives. Also, work at home and alternative work schedules were not particularly popular strategies in the first year of these programs. What is perhaps surprising is the relatively high rate of employers offering transit subsidies, even among the smaller employers, and even when transit service is not particularly good. One conclusion that might be drawn is that as employers are compelled to add strategies, it is relatively inexpensive to offer transit subsidies if it isn't likely that they will actually be used.

Table 19-25 Application of Strategies by Employer/Institution Size

TDM Strategy	Percentage of Employees Offered Strategy by Employer Size Range (Sample Size) < 100 (2)	100-499 (34)	500-1,000 (7)	> 1,000 (39)	All Sizes (82)
Info Center/ETC	50.0%	76.5%	57.1%	76.9%	74.4%
Rideshare Matching	0.0	58.8	71.4	79.5	68.3
Guaranteed Ride	0.0	76.5	57.1	56.4	63.4
On-Site Pass Sales	50.0	8.8	14.3	28.2	19.5
Fairs/Promotions	50.0	8.8	14.3	33.3	22.0
On-Site Services	0.0	11.8	0.0	7.7	8.5
Preferential Parking	0.0	29.4	28.6	64.1	45.1
Bike Racks/Showers	100.0	44.1	14.3	61.5	51.2
Company Vehicles	0.0	14.7	14.3	10.3	12.2
Vanpool Program	0.0	8.8	0.0	48.7	26.8
Transit Services	0.0	2.9	14.3	25.6	14.6
Restricted Parking	0.0	32.4	42.9	61.5	46.3
Parking Fees	0.0	35.3	42.9	43.6	39.0
HOV Parking Discounts	0.0	20.6	42.9	20.5	22.0
Transit Subsidies	0.0	64.7	71.4	69.2	65.9
Transp. Allow./Cash-Out	0.0	17.6	0.0	12.8	13.4
Other-Mode Subsidies	0.0	29.4	57.1	51.3	41.5
Other Monetary Incentives	0.0	11.8	0.0	20.5	14.6
Flextime	0.0	64.7	28.6	56.4	56.1
Staggered Hours	0.0	2.9	0.0	12.8	7.3
Compressed Work Week	0.0	41.2	14.3	43.6	39.0
Telecommuting	0.0	11.8	14.3	25.6	18.3

Sources: Derived (see Appendix Table 19-A) from Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

Also of interest is what happens over time to TDM programs, as experience is gained and the need arises to either secure more trip reduction impact or improve cost-effectiveness. The same study that provided the information for Table 19-26 developed a comparison on how the preference for strategies changed between program Years 1 and 2. The results are shown in Table 19-27, which compares the frequency of offered strategies in terms of the number of employees exposed to them. Next to the number is the corresponding rank, with "1" being the most commonly applied strategy in that year. The final column shows the change in rank between Years 1 and 2, calculated as the difference between the first- and second-year rankings. The top 10 strategies in Year 1 were, in order: (1) on-site services, (2) ongoing transit subsidy, (3) regional ridematching, (4) commuter information center, (5) internal rideshare matching, (6) flextime for ridesharers, (7) preferential parking, (8) drawings and prizes, (9) guaranteed ride home, and (10) transit information. In Year 2, the preference order changed to: (1) showers and lockers, (2) on-site services, (3) regional ridematching, (4) commuter information center, (5) marketing/other, (6) guaranteed ride home, (7) internal rideshare matching, (8) drawings and prizes, (9) preferential parking, and (10) passenger loading areas.

Table 19-26 Strategies Offered in Year One by Company Size—SCAQMD (Los Angeles)

TDM Strategy	Number of Employers Offering Strategy by Size Group (Sample Size) < 100 (43)	100-199 (96)	200-499 (278)	500-1,000 (383)	> 1,000 (584)
Preferential Parking Areas	27	64	197	252	436
Ongoing Transit Subsidies	31	57	146	217	326
Prize Drawings, Raffles	27	47	153	208	295
Bike Racks	24	50	130	178	250
Regional Rideshare Matching	21	43	107	142	218
Transit Information/Racks	14	27	89	133	210
Guaranteed Ride Home	17	33	79	117	207
Flextime for Ridesharers	12	21	78	134	197
Employer Rideshare Matching	14	30	84	129	181
Ongoing Carpool Subsidies	7	29	97	138	180
New Hire Orientation	18	26	67	118	166
Commuter Info Center	9	14	74	110	157
Employee Benefits and Services	20	31	73	105	151
Showers and Lockers	10	26	58	78	149
Marketing Elements - Other	11	20	84	118	147
On-Site Services	13	19	49	69	120
Bike to Work Subsidies	6	20	64	91	114
Ongoing Vanpool Subsidies	2	8	46	50	113
Walk to Work Subsidies	13	28	65	92	109
4/40 Work Schedule	3	11	37	74	108
Company Owned/Leased Vans	3	5	35	64	108
Commuter Fairs	4	7	36	65	87
Use of Company Vehicles	2	10	27	43	82
Company Recognition	11	17	44	48	70
Work At Home	3	5	27	33	68
On-Site Auto Services	22	24	34	41	59
Direct Financial Incentives	6	10	25	29	55
9/80 Work Schedule	1	7	11	37	41
Additional Time Off with Pay	3	13	21	19	39
Subsidized Rideshare Parking		1	5	7	28
3/36 Work Schedule	1	4	10	13	23
Facility Improvements	4	8	4	10	18
Parking Management Strategies	2	5	12	13	17
Passenger Loading Areas	1	1	2	3	17
Parking Fees for Drive Alones			4	9	13
Childcare Services		4	2	3	11
Work at Satellite Center		1		7	5
Transportation Allowance			1	2	5

Source: Drawn from SCAQMD Regulation XV Database as published in JHK & Associates (1992).

Table 19-27 Change in Type of Strategies Offered in Year 2 Versus Year 1—SCAQMD (Los Angeles)

	Employee Exposure to Strategies				
TDM Strategy	Year 1	Rank	Year 2	Rank	Rank Change (Year 1 to Year 2)
Passenger Loading Areas	4,364	31	53,178	10	21
Showers and Lockers	15,886	16	198,945	1	15
Marketing Elements - Other	22,935	13	65,785	5	8
Direct Financial Incentives	3,304	33	5,390	26	7
On-Site Auto Services	5,181	27	9,856	21	6
Additional Time Off with Pay	2,883	35	4,168	30	5
New Hire Orientation	14,405	17	27,662	14	3
Company Recognition	16,674	15	31,697	12	3
Guaranteed Ride Home	32,877	9	61,430	6	3
Parking Fees for Drive Alones	3,010	34	3,362	32	2
Transportation Allowance	950	37	1,824	36	1
Work At Home	2,417	36	1,858	35	1
Parking Management Strategies	4,477	29	4,812	28	1
Commuter Fairs	13,331	18	23,861	17	1
Work at Satellite Center	603	38	32	38	0
Prize Drawings, Raffles	38,090	8	55,236	8	0
Commuter Info Center	57,027	4	80,675	4	0
Regional Rideshare Matching	72,579	3	87,658	3	0
Walk to Work Subsidies	4,411	30	3,477	31	-1
Bike Racks	5,921	24	5,399	25	-1
3/36 Work Schedule	10,414	19	15,083	20	-1
On-Site Services	179,412	1	97,734	2	-1
Bike to Work Subsidies	3,876	32	2,839	34	-2
Subsidized Rideshare Parking	5,466	25	4,872	27	-2
9/80 Work Schedule	6,994	22	6,223	24	-2
Facility Improvements	7,506	21	6,965	23	-2
Ongoing Vanpool Subsidies	7,823	20	8,266	22	-2
Preferential Parking Areas	41,809	7	53,398	9	-2
Employer Rideshare Matching	56,667	5	56,102	7	-2
Employee Benefits and Services	23,444	12	25,213	15	-3
Transit Information/Racks	28,603	10	31,610	13	-3
4/40 Work Schedule	19,120	14	20,085	18	-4
Ongoing Carpool Subsidies	27,339	11	24,940	16	-5
Flextime for Ridesharers	46,003	6	37,193	11	-5
Introductory Transit Subsidies	5,927	23	4,767	29	-6
Company Owned/Leased Vans	5,256	26	3,323	33	-7
Childcare Services	4,751	28	1,344	37	-9
Ongoing Transit Subsidies	95,461	2	19,116	19	-17

Source: Drawn from SCAQMD Regulation XV Database as published in JHK & Associates (1992).

Table 19-27 is ordered by which strategies had the biggest changes in rank. At the top of the list, passenger loading areas gained 21 net points in rank, showers and lockers gained 15 points, marketing gained 8, direct financial incentives gained 7, and on-site services gained 6. Most of these measures are "soft" strategies, as previously noted in the "Voluntary Versus Regulatory Employer Motivation" discussion above.

Ongoing transit subsidies fell by 17 ranking points, company vans by 7 points, and introductory transit subsidies by 6 points. One should also look at the actual employee participation numbers as well as the rank change, in order to have a proper appreciation of the relative scale of each strategy's popularity. For example, while SOV parking fees increased in rank by 2 points, this only represents a change in position from 34th to 32nd place.

These SCAQMD-regulated employer shifts in strategy, with their failure to take on or even stick with much in the way of financial incentives and disincentives or transportation services, held trip reduction to modest levels. Employment sites involved for the longest time period achieved, in 3-plus years, slightly over a 7 percent average reduction in journey-to-work vehicle trips per employee. Results from sites with greater progress were partially washed out in regulated-employer averages by diminished success on the part of a number of firms that actually started out with high performance. SCAQMD results are further discussed in the "Related Information and Impacts" section under "Site- Versus System-Level Impacts"—"Intermediate Effects of Dissipation."

Land Use and Site Design

A growing number of research studies have investigated the link between transportation and land use at the residential end of the trip, but fewer have probed the synergy between travel behavior and land use at the destination. It would seem reasonable to assume that a work site located in an attractive setting with good walkability, access to transit, and convenient proximity to attractions and services would find it easier to entice commuters from their cars. A major reason often given for driving to work is that the worksite is located in an area that is isolated from any other activities, requiring a personal vehicle to tend to midday needs for lunch, errands, or going to meetings.

A more complete discussion of such relationships is found in Chapter 15, "Land Use and Site Design." See also Chapter 17, "Transit Oriented Development," for additional information. Reported on here in Chapter 19 are two studies specifically designed to examine the relationship of employment area land use and site characteristics to TDM effectiveness.

TCRP Project B-4, introduced earlier and described in Footnote 2, obtained information via survey from 50 different employers on their TDM programs and also on employer and site characteristics. With this information, an attempt was made to determine the approximate number of services reachable within a 5-minute walk. Correspondence between this local accessibility and the calculated VTR was found to be surprisingly strong. The 11 employment sites rated as having "poor" access to services (2 or less) averaged a VTR of only 5.3 percent. The 11 sites rated as having "fair" access (3 to 5 services) averaged an 8.3 percent VTR, while those 25 with "good" access (more than 5 services) averaged 21.5 percent.

Influences beyond local accessibility were quite possibly a factor—the accessibility measure may have acted as a surrogate for urban conditions in general. The types of TDM programs implemented in these various settings do show some important differences, with 23 of the 25 programs in the "good" access category offering financial incentives. On the other hand, eight of the 11 programs in the "fair" category and seven of the 11 in the "poor" category also offered financial incentives (Comsis, 1994).

A more deliberate and comprehensive attempt to investigate the synergy between land use and TDM impact was made in a study for the Federal Highway Administration (FHWA). The researchers selected a sample of 330 employment sites in Los Angeles County that were participating in the Regulation XV program, and appended information on a wide range of land use and site design characteristics to existing data file information on TDM program characteristics and employee travel. The expanded data were then analyzed both descriptively and statistically.

Overall, the sample of 330 programs indicated the following shifts in behavior in relation to the first Regulation XV plan (Cambridge Systematics, 1994):

- Drive-alone share decreased from 76.2 percent to 71.4 percent, while carpool/vanpool share increased from 13.4 percent to 18.8 percent.

- Small mode share *losses* were incurred by both transit (down from 4.6 to 4.4 percent) and bike/walk (down from 5.8 to 5.4 percent) as an apparent result of the initial program.

It is not clear whether this outcome reflected an overemphasis on programs and incentives for ridesharing (as suggested by the study) or whether transit and bike/walk were simply not as viable as ridesharing in this travel market. Flexible work schedule shares (telecommuting and CWW) also declined, from 3.8 to 3.1 percent. AVR increased from 1.213 to 1.245, equating to a VTR of 2.5 percent.

The 330 sites were a randomly selected subsample from a database of 1,100 employers who had completed at least one trip reduction plan under Regulation XV. The land use data were compiled for the following three different levels of geographic resolution (Cambridge Systematics, 1994):

- The surrounding subarea (1/2 to 2 square miles), recording land use mix, predominant land use type, building types and special features, main streets, traffic levels, sidewalks, and landscaping.

- The immediate environs (1/4-mile radius), recording horizontal and vertical land use mix, specific land uses present, number and type of and distance to services, street characteristics, "streetwall" characteristics, sidewalks, pedestrian activity, and landscaping.

- The actual site, recording the number and characteristics of parcels and blocks, building architecture, size and orientation, on- and off-street parking, access to bus stops, sidewalks, and street life.

The research approach was to then try to explain the change in modal share for the 330 employers based on both the characteristics of their TDM programs and the land use characteristics of the sites. Given the large number of TDM strategies and land use/site descriptors, it was found necessary to pare and consolidate the list of measures into index-type variables. TDM program strategies were divided into five categories: assistance programs, financial incentives, awards programs, flexible work schedules, and other. The land use characteristics were also partitioned into five categories, as follows:

- Mix and variety of land uses within 1/4 mile.

- Availability of convenience services (number and mix of key services within 1/4 mile).

- Walk accessibility to convenience services (design of area to promote walking).

- Perception of safety (sidewalks, street lights, pedestrian flow, number of vacant lots).

- Aesthetics (sidewalk widths, landscaping, absence of graffiti).

Initial analysis of the link between the observed changes in mode share and the TDM strategies applied at the 330 employers revealed that only financial incentive strategies were statistically significant. Therefore, for the TDM aspect of the analysis the researchers basically distinguished programs (employers) with financial incentives from those without. The five land use measures were similarly treated as having a "low" or "high" value for the particular index. A summary of the findings corresponding to this structure is presented in Table 19-28 (Cambridge Systematics, 1994).

Overall, the findings suggest that for drive alone, carpool/vanpool, and flexible work schedules, the impact of the TDM financial incentives is measurably more important on changing share than any of the land use measures. In fact, for carpool/vanpool, better land use—specifically as represented by land use variety, availability of convenience services, and walk access to services—actually was associated (at least in the model) with a *decrease* in the use of that mode. With transit, however, and to a lesser extent bike/walk, supportive land use proved to be very important, increasing the shares for these modes.

It is also interesting to note that the combination of financial incentive TDM programs with better land use is almost always synergistic, i.e., it produces a higher net effect on both mode share and AVR than the two measures independently. The notable exception is carpool/vanpool, where combining the measures was identified as being detrimental to carpool/vanpool share in all but the category of aesthetic appeal, which—somewhat surprisingly—is overall the most influential measure of land use identified by the study. It is difficult to comprehend how the elements captured in the aesthetics measure would have more influence on mode share than the other four measures, unless the measure is somehow acting as a surrogate for other aspects of the environment that were not captured by the set of indices.

Table 19-28 Combined Effect of TDM Financial Incentives and Land Use Characteristics on Mode Share and AVR

Presence of TDM Financial Incentives (Without/With)	Modal Share with Low and High Prevalence of Specified Land Use Characteristics									
	Variety of Land Uses		Availability of Convenience Services		Walk Access to Convenience Services		Perception of Safety Level		Aesthetic Appeal	
	Low	High	Low	High	Low	High	Low	High	Low	High
Drive Alone										
Without	77.2%	75.2%	76.7%	75.2%	76.4%	76.0%	79.0%	75.1%	77.0%	72.4%
With	71.7%	70.8%	72.4%	69.6%	72.1%	70.5%	73.2%	70.6%	73.2%	66.6%
Transit										
Without	3.6%	5.5%	3.7%	6.1%	3.5%	5.5%	3.9%	4.8%	3.9%	7.8%
With	2.9%	6.4%	3.4%	7.1%	3.0%	6.3%	3.6%	5.4%	4.2%	8.3%
Carpool/Vanpool										
Without	13.4%	13.0%	13.4%	12.5%	13.8%	13.0%	12.8%	13.6%	13.3%	13.9%
With	18.7%	17.7%	18.6%	17.5%	18.8%	17.7%	18.4%	18.0%	17.9%	18.9%
Bike/Walk										
Without	3.0%	3.6%	2.9%	4.0%	2.9%	3.6%	2.2%	3.7%	3.2%	3.9%
With	2.6%	3.1%	2.6%	3.3%	2.2%	3.3%	1.7%	3.2%	2.6%	3.9%
Flexible Work Schedules	(Percent Flexing Schedules Without and With Financial Incentives)									
Without	2.4%	2.7%	2.4%	2.8%	3.4%	1.8%	2.2%	2.7%	2.7%	2.0%
With	4.0%	1.9%	3.0%	2.4%	3.8%	2.1%	2.9%	2.7%	2.9%	2.3%
AVR										
Without	1.218	1.229	1.224	1.223	1.225	1.222	1.206	1.230	1.211	1.285
With	1.230	1.271	1.230	1.286	1.229	1.272	1.229	1.263	1.235	1.337

Source: Cambridge Systematics, Inc. (1994).

Trip Chaining

A significant issue related to the importance of the land use adjacent to the work site is the matter of trip chaining. It has been argued that a major deterrent to shifting commuters away from driving alone and into transit, ridesharing, or other alternatives is the degree to which they are dependent upon their cars for needs and activities which occur at, or on the way to or from, the work site. Particularly in suburban areas, where work sites tend to be isolated from other land uses (especially services), commuters can feel justifiably nervous about abandoning their cars.

In response to this isolation and dependency, commuters double-up on the purpose of their commute trip by incorporating additional stops on the way to or from work. These multi-stop trip tours, or "trip chains," introduce an additional challenge and complexity to planning for TDM programs. Multi-task commute trips are commonplace, and often hard to accomplish when not driving alone. When trying to entice the drive-alone commuter into a wholesale shift to an alternative mode, much depends on how essential these intermediate stops are to the household, how frequently they are made, and whether or not there are options at the home or work end of the commute trip that can satisfy the same needs.

A thorough study of this phenomenon was performed in the Brentwood area of Nashville, Tennessee, using survey data obtained from a sample of 1,845 employees representing 42 employers in this predominately suburban district. The survey probed in detail into the frequency with which the commuters made stops on the way to or from work, and also into their purpose. The survey found that only 9 percent of all workers surveyed traveled directly to *and* from work without stopping—the vast majority made routine stops. It also found that stops on the return-home trip were twice as likely as stopping on the way to work. Table 19-29 gives an indication of how frequently trip chaining occurred (Davidson, 1991).

Table 19-29 Frequency with which Non-Work Stops Are Not Added to the Commute Trip, Suburban Nashville, Tennessee

	Number of Days Respondents Go Directly To/From Work *Without* Chaining Trips					
Trip Direction	**5**	**4**	**3**	**2**	**1**	**0**
To Work	49%	18%	11%	5%	2%	15%
From Work	19%	22%	26%	15%	5%	13%

Source: Davidson (1991).

The display shows the frequency with which employees traveled to or from work *without* making additional stops along the way. It reveals that almost one-half, 49 percent, of the commuters studied essentially never stopped on the way to work, although only 19 percent traveled from work to home without making a stop at least 1 day a week. So, viewed the opposite way, 51 percent of commuters stopped at least once a week on the way to work, and 81 percent stopped at least once a week on the way home from work. The other interesting statistic in this display is the proportion of commuters who *always* stopped along the way: 15 percent of commuters stopped daily on the way to work and 13 percent stopped daily on the way from work. The average number of days a stop was made on the way to work is 1.38, while on the way home the average is 2.0 days per week.

The predominant reason given for stopping was to get fuel for the vehicle. This activity accounted for 45 percent of the stops on the way to work and 63 percent of the stops on the way home from work. In approximate order of decreasing prevalence, other reasons given were: going to the bank (23 percent of trips to work and 50 percent of trips from work), visiting the dry cleaners (19 percent to and 31 percent from), getting something to eat (16 percent to and 20 percent from), shopping (12 percent to and 56 percent from), work-related activity (10 percent to and 13 percent from), child care (10 percent to and 10 percent from), taking a child to or from school (10 percent to and 6 percent from), visiting a doctor (6 percent to and 14 percent from), transporting another person including carpool (7 percent to and 7 percent from), exercise (2 percent to and 11 percent from), and entertainment (1 percent to and 9 percent from) (Davidson, 1991).

The data were also manipulated to examine patterns in the way trips were grouped into chains and correspondence between morning and evening stops. For example, it was noted that the purposes which most often occurred on both the trip to work and the trip home were child care (91 percent), dropping off children (80 percent), stopping to eat (33 percent), and stopping at the dry cleaners (33 percent). It was also discovered that for those commuters who stopped for gas on the way to work (45 percent), 21 percent would also stop to eat, 16 percent would visit a dry cleaner, 16 percent would stop at the bank, and 12 percent would attend to child care.

This latter type of assessment begins to suggest strategies for successful TDM efforts. For example, if a drive-alone commuter were to shift to a vanpool, the need to stop for fuel could be virtually eliminated. However, to make the shift more permanent, it would be necessary to find a way to provide better access to banking, dry cleaners, and eating establishments on or near the site. Employees' expressed preferences for on- or near-site services included: post office (32 percent), restaurant (31 percent), general retail (25 percent), snack bar (20 percent), exercise facility (19 percent), convenience store (18 percent), dry cleaners (11 percent), and medical care (10 percent). The conclusion drawn by the study was that while linked trips had a negative effect on TDM efforts, a better mix of land uses or the delivery of services to employer sites might go a long way toward reducing auto dependency and making TDM more effective (Davidson, 1991).

RELATED INFORMATION AND IMPACTS

Synergy and Complementarity

The body of empirical information compiled on TDM programs makes it fairly evident that the effectiveness of these programs depends on several key factors:

- Marketing, information, and promotional strategies are clearly important catalysts in successful TDM programs by raising awareness, knowledge of, and interest in commute alternatives. However, ultimately a TDM program has to offer the commuter an attractive alternative to driving alone, in which instance the marketing and promotion is essential in ensuring that the employee understands the advantages of the choice. However, if competitive alternatives are not provided, simply trying to convince the commuter that driving is wrong and some other approach is more acceptable will be ineffective and short-lived in changing behavior.

- Driving alone has many strong advantages for the commuter, including schedule management, travel time, and even out-of-pocket cost in many cases. Travel demand research tells us that travel time and cost are primary determinants in the choice among modes. If a traveler cannot save time by choosing an alternative mode (because buses or carpools travel the same congested roads as SOVs) or cost (cars are given free parking whereas transit users must pay a fare), it is difficult to persuade the commuter that it makes economic sense to not drive. Hence, any strategies that help even out this competitive disadvantage—management of the supply or price of employee parking, priority access or routing for buses or car/vanpools, or modal subsidies—make an alternative mode easier to promote.

- Strategies must be appropriate to the travel environment in which they are applied; for example, widespread offering of transit subsidies may not mean much if the level or quality of transit service is poor.

- The effect of individual strategies is enhanced if they are combined with other strategies which are known to be "synergistic." For example, providing transportation services is likely to have greater impact if the offering is paired with financial incentives such as user subsidies, and providing carpool matching services and HOV reserved spaces is more likely to be effective if employees driving to the worksite are not guaranteed free parking.

- The synergy of employer commitment and engagement has a key role to play as well. "Employment-based programs work when a party accountable for performance . . . is experiencing a critical problem (parking, congestion, regulation) that demand management can solve, puts resources into solutions, follows through on implementation, changes activities and resources based on actual performance, and demands results" (Valk, 2007).

- Alternative work hours/schedules may have conflicting effects. Evidence suggests that a policy of flexible work hours can be an important incentive for employees who rideshare or use transit, as it allows them greater latitude to deal with the scheduling demands of those modes. On the other hand, strategies like CWW and telecommuting appear to be more neutral and—although more research is needed—may even detract from the use of alternative modes. Attractive combinations within the 82-program sample occur when the privilege of a modified work schedule is tied to the use of alternative modes.

Informed program design and development is obviously crucial. Efforts to enhance the TDM program development process, largely in the hands of employers, are covered in the next two subsections in particular.

Program Development Outreach and Support

The success of TDM programs clearly depends on the level of information and assistance that is made available to the individual employers. Employers faced with a requirement or need to reduce vehicle trips are placed into unfamiliar territory, where they must somehow identify a set of actions that not only will help meet their trip reduction goal, but also be affordable and compatible with the type of business activity in which they are engaged. Whether motivation to reduce employee vehicle use is caused by regulation or a desire to either reduce demand for scarce parking or to provide helpful alternatives for employees stuck in traffic, employers are typically ill-equipped to design and implement effective programs. They are also constrained by an underlying concern of not wanting to frustrate employees or impose an action that will threaten their competitive advantage in finding and retaining workers/staff.

Agencies such as the South Coast Air Quality Management District (SCAQMD), which was charged with administering the requirements of Regulation XV in Southern California, have employed a variety of methods to provide guidance and technical assistance to affected employers. SCAQMD developed a range of tools to help employers learn how to develop a trip reduction plan, and increasingly (as more information became available) provided technical support for selection of strategies. Consultant expertise increased as well. Ultimately, SCAQMD, with help from CARB, undertook development of a Travel Demand Management Program to provide improved guidance on selection of strategies capable of achieving trip-reduction goals. This information was made available to employers in the form of software and also a hard-copy manual. A description of this research is provided in the next subsection, "Modeling Studies."

Other, less formal approaches to sharing information, building support, and shaping effective programs than those of the regulatory agencies are evident in the marketing and outreach programs of local and regional governments, transportation agencies, and transportation management associations (TMAs). Most metropolitan planning agencies actively support employer TDM efforts, often in support of efforts to attain or maintain federally mandated air quality standards. For example, the Metropolitan Washington Council of Governments operates an ambitious suite of programs, termed Commuter Connections, through which it provides a range of information, outreach, and technical assistance in support of TDM (LDA Consulting, 1999). Commuter Connections operates an employer outreach program to encourage large, private sector employers to voluntarily implement TDM strategies to reduce vehicle trips by employees. It offers an integrated rideshare program that provides regional rideshare matching as well as information on other alternative modes to all who receive a matchlist, a guaranteed ride home program in which it runs a regional emergency ride service for participating employers across the region, a telework resource center through which it provides information and assistance to commuters and employers to further in-home and satellite center telework programs, and a network of information kiosks in many locations to provide transit route and schedule information, maps, and rideshare information.

Sometimes TDM program development information and technical assistance is provided by the public transit agency, through a special regional ridesharing organization, or through TMAs. Many transit agencies actively work with employers to provide better information to employees on transit alternatives, to assist in selling commuter passes on-site, and to encourage employers to subsidize their employees' transit costs through programs like TransitChek in New York and Philadelphia and Snap Pass/PASSport in Portland, Oregon, both of which have been discussed earlier in this chapter. At one time, regional ridesharing agencies were popular fixtures in many urban areas, such as Commuter Transportation Services in Los Angeles and Commuter Computer in Pittsburgh. These organizations eventually broadened their scope to promote alternative modes other than just ridesharing or vanpooling. A number were assimilated into the corresponding Metropolitan Planning Organization (MPO) when air quality became an important driver for promoting alternative modes, following the passage of the Clean Air Act Amendments of 1990, and the introduction of transportation conformity legislation in several states and jurisdictions.

A highly innovative program was conceived and implemented by Seattle Metro, now King County Metro, the public transportation agency for Seattle/King County, in the mid-to-late 1980s. Beginning with the development of its 1990 Transit Plan in 1981, the agency realized that it needed to broaden its base of products and services beyond simply fixed-route transit service. Proliferation of significant new activity centers outside the Seattle CBD posed an entirely different set of travel needs than those served by traditional CBD-oriented bus service. In January 1986, Metro undertook a restructuring that reflected a shift to a market-oriented approach, emphasizing different products and services for the new developing markets.

One element of this shift was to incorporate Commuter Pool, the regional carpool and vanpool agency, into Metro. Another element was the establishment of a Research and Market Strategy function to act as a leading edge in identifying, marketing, and evaluating new products and services. This action morphed Metro into more of a "mobility broker," packaging and selling both services and assistance appropriate to the marketplace. Included were a wide range of transit services and High Occupancy Vehicle (HOV) facilities, service contracts with major employers, and a giant university pass program (U-PASS at the University of Washington), as well as carpool matching, vanpool program management, and telecommute program assistance. To make these programs as effective as possible, Metro worked extensively with local communities, TMAs, and with individual employers to design the programs and ensure maximum flow of information down to commuters (Comsis, 1991).

Perhaps one of the most interesting elements of Metro's program activities was the HOV/TSM evaluation study, a 2-year study to evaluate the effectiveness of a set of transportation programs, incentives, and promotional techniques applied in four project areas in King County. Beginning in 1987, Metro began monitoring the performance of TDM programs at 52 suburban employment sites, each having received some program assistance from Metro to establish a TDM program. These sites, along with a group of regional control sites where no special actions were taken, were tracked using employee surveys. The results were used to ascertain employee awareness of programs and incentives available to them, and to track changes in mode shares as influenced by the programs.

As a primary tactic, transportation coordinators were hired for each project area to provide personalized assistance to employees in planning their commute and taking advantage of marketed transportation programs and incentives. The initial evaluation surveys, as previously discussed in connection with Table 19-21, demonstrated a surprisingly low level of employee awareness of particular programs and incentives that were available to them. The most visible effect of the transportation coordinators' (TCs) efforts was on measurable increases in employee awareness.

Between 6 percent and 19 percent of employees in the four project areas changed commute mode between 1988 and 1989, and overall, 5.5 percent of employees in these four areas stopped driving alone and began using an HOV mode. However, the same proportion discontinued their HOV use and began driving alone, with the result being no net change in mode split. Meanwhile, at the control sites, 4.7 percent of employees shifted from driving alone to use of an HOV mode, but a slightly greater percentage, 6.0 percent, changed from HOV to driving alone.

The interpretation of these results by Metro was that in an environment where there are few good alternatives, plenty of free parking, and considerable staff turnover with new hires, the TDM outreach activities helped prevent net losses in HOV mode use in the managed areas. For those employees who shifted from driving alone to an HOV mode, 48 percent of those individuals cited one or more of the TC activities as affecting their choice, whereas 39 percent of employees at the control sites cited TC activities. Among employees who switched from HOV to driving alone, only 18 percent of those working in the four project areas cited TC activities as affecting their choice, and 11 percent of employees in control areas cited TC activities (Municipality of Metropolitan Seattle, 1990).

Modeling Studies

California Air Resources Board Survey and TDM Program

Critical limitations in the travel and impact data compiled and released in the large-scale state and regional employer TDM programs have been outlined in the "Analytical Considerations" subsection of the "Overview and Summary." In appreciation of these shortcomings, CARB sponsored a research study, in 1993, centered on the collection of original travel survey data from an acceptably large and diverse employer sample in the Los Angeles and Sacramento air quality management areas.

The objective was to develop a mathematical tool that would be credible for designing or testing the capability of employer TDM programs to meet mandated trip reduction goals. Detailed travel data were acquired from 2,437 employees at 45 different employers, along with sufficient information to permit geocoding of trip origin and destination, which was used to append corresponding travel time and cost of available travel alternatives from the respective regional travel models. An attempt was then made to evaluate the effectiveness of particular TDM strategies through the estimation of logit-type mode choice models. These models were structured to predict the probability of choosing a particular travel option in relation to individual travel characteristics and the strategies applied by the respective employer (Comsis, 1993a).

The results of this modeling exercise are summarized in Table 19-30, presenting parameter estimates for those variables that were found to be statistically meaningful in selection of the respective travel mode. The first group of variables in the table represents the travel time and cost variables typically at the heart of mode choice models. The modeling analyst compared the coefficients for in-vehicle time, transit out-of-vehicle time, auto operating cost, transit fare, and parking cost with the estimates from ten other metropolitan area travel models and found them to be satisfactorily comparable in both relative and absolute magnitude.

Table 19-30 CARB TDM Model Parameter Estimates

Variable	Coefficient Values				
	Drive Alone	Carpool	Vanpool	Transit	Bike/Walk
Mode-Specific Constants		-1.517	-7.070	-3.048	-2.153
Travel/Transportation-System Variables					
In-Vehicle Time (IVT-minutes)	-0.0399	-0.0399	-0.0399	-0.0110	
Out-of-Vehicle Time (OVT-min.)				-0.0165 [a]	-0.0441
Operating Cost/Fare (cents)	-0.0034	-0.0034	-0.0034	-0.0061	
Parking Cost (cents)	-0.0086	-0.0086	-0.0086		
Availability of Bike Lanes					1.220
Employee Characteristics Variables					
Laborer (1=Yes)		0.3999		0.9367	
Professional (1=Yes)		-0.2666	0.9054		
Manager (1=Yes)				-1.064	
Gender (1 = Male)					0.8727
Elderly (1=Yes)		0.5262	0.4355 [b]	0.9089	
Midday Business Travel (1=Yes)		-0.7745			
Staggered Work Hours (1=Yes)				0.8148	
Part-Time Worker (1=Yes)				0.5377 [b]	
Single Worker Household (1=Yes)		-1.027			
Married (1=Yes)			0.9944		
Worksite Characteristics Variables					
Parking Spaces per Employee				-0.4155 [b]	
Campus/Institution (1=Yes)		-0.8150			
No. Adjacent Retail Land Uses		0.1069		0.1069	
TDM Strategy Variables (1=Yes)					
ETC and Rideshare Matching		0.0777 [c]	0.0777 [c]		
Preferential Rideshare Parking		0.1214 [b]	0.1214 [b]		
Transit Info Center and Pass Sales				1.083	
Bike Racks or Showers/Lockers					0.4056 [b]
Guaranteed Ride Home		0.4476	0.4476	0.4476	0.4476
Modal Subsidy		0.0125	0.0125		0.0125
Prizes, Meals, Awards		0.0826 [d]	0.0826 [d]	0.0826 [d]	
Use of Company Vehicles		0.7861	0.7861		
Company-provided Vans			2.586		

Notes: Unless otherwise noted, all coefficients are significant at 95 percent confidence level.

[a] Value constrained to 1.5 times IVT coefficient. [b] Significant at 80% confidence level.

[c] Not significant at 80% confidence level. [d] Coefficient derived from other sources.

Source: Comsis (1993a).

The second group of variables represents employee characteristics. The estimates imply that workers who are laborers are more likely to choose carpool or transit, especially transit, while professionals and managers are among the least likely to choose those modes. Professionals are most likely to choose vanpooling as a commute alternative. Males are the most likely to bike or walk, while the likelihood of carpooling, vanpooling or taking transit is clearly greater for older workers. Persons who must make midday business trips are fairly unlikely to want to carpool, but for some reason that effect doesn't seem to carry over to vanpooling or transit.

A modeled relationship that seems inconsistent with other findings is that employees on staggered work hours are much more likely to take transit. Part-time workers are more likely to opt for transit as an alternative, not surprising since other ridesharing modes require daily commitment. Employees who are the sole worker in the household are less likely to carpool, but do not seem to be discouraged by transit or vanpooling, while married employees are most likely to choose vanpooling.

A limited set of worksite characteristics constitutes the third group of variables. Testing of the worksite variables suggests that transit use is likely to be less where parking space ratios are higher, that carpooling is less likely at campus locations or institutions, and that as the number of adjacent retail land uses increases, the rate of carpooling and transit use will increase (Comsis, 1993b).

The above relationships helped set the stage for evaluating the contributions of TDM strategies (labeled "incentives" in the study). The TDM strategies shown in the lower portion of Table 19-30 were the only "incentives" that could be quantified as strategy-specific variables in the models. Their relationships with the respective mode choice observations were strong enough that statistical significance could be demonstrated. This does not mean, however, that the value of individual coefficients is regarded as wholly plausible in all cases.

Having an employee transportation coordinator (ETC) and offering rideshare matching is estimated to have a moderately positive influence on employee choice of carpooling or vanpooling (the two measures were only significant when combined), as does the offering of preferential parking. Predictably, maintaining a transit information center and offering on-site transit pass sales has a fairly solid positive influence on choice of transit, while offering bike racks or showers/lockers has a moderately positive effect on the decision to bike or walk. Offering use of company vehicles has a clearly positive effect on carpooling or vanpooling choice, while providing company vans has a very substantial effect on vanpooling choice.

A dilemma arises in the estimates shown for Guaranteed Ride Home (GRH) and the monetary incentives (modal subsidies). GRH has a surprisingly large effect in the model on commuter choice of all alternative modes, at a level (model coefficient of 0.4476) that exceeds most other strategies. This finding stands in contrast to the relatively modest effect of providing modal subsidies (0.0125). The offering of prizes, free meals, and awards also garners a higher coefficient value (0.0826) than does provision of modal subsidies.

There are several possible explanations for this apparent anomaly. First, GRH has been demonstrated to be a very popular and highly demanded feature of an employer TDM program, so it is possible that it actually does carry a higher value in employee choice of alternative commute modes. Second, the survey did not ask what the monetary value was of either the financial incentives or the cost of parking at the worksite, so a wide range of dollar magnitudes was presumably lumped together. Third, it is probably useful to note that, while the data collected explicitly for this study were both more reliable and less aggregated than those found in the regulatory agencies' databases, they do represent only a single point in time—when the survey was conducted. They reflect behavior inside an employer that was applying certain combinations of TDM strategies, but how long it had been since the strategies had been implemented could not be known, nor could there be empirical identification of the degree to which introduction of any of the individual strategies directly affected employee travel choice.

Another matter of interest is the degree to which individual employees were aware of the availability or implication of particular TDM strategies. Because employees were asked to identify particular TDM strategies made available by their employer, it was possible to cross-check against what strategies were actually available. As described and tabulated in the "Underlying Traveler Response Factors" section, under "Individual Behavioral and Awareness Considerations"—"Awareness and Comprehension of Options" (see Table 19-21), the program awareness of employees ranged from 77 percent for preferential parking down to only 17 percent for bus pass discounts and 15 percent for transportation fairs.

Awareness was seen as such an important issue that it was decided to attempt to model the percent awareness for the eight TDM incentives that were included in the mode choice model. Submodels were calibrated to accompany the mode choice model, with separate equations calculated for each incentive. Test plots led to the use of annual ETC marketing plus administrative cost per employee as offering the best explanation for variations in awareness.

The implication of this relationship is that higher levels of marketing, outreach, and information exchange lead to a more informed, and hence more "aware" employee, which translates to the TDM strategies having greater use and impact. Ultimately, this chain of mode choice-TDM Incentive-awareness relationships provided the basis for a software tool known as the Travel Demand Management Program, which was pilot tested by SCAQMD in Los Angeles (Comsis, 1993a). The software's Users Guide summarizes the default coefficient values for each model (Comsis, 1993b).

Center for Urban Transportation Research Worksite Trip Reduction Model

A more recent attempt to model the effects of TDM strategies on travel behavior was undertaken by the University of South Florida's National Center for Transit Research Program at CUTR. This research set out to use as its primary data source the employer plan data compiled under California's Regulation XV/Rule 2202 program, as well as comparable data from Washington State's Commute Trip Reduction Law, and the Pima Association of Governments in Tucson, Arizona (CUTR, 2004).

The CUTR researchers quickly recognized the same challenges in working with these data that had been experienced by the research efforts mentioned earlier, namely problems of aggregation, missing or incomplete employer plan records, and insufficient information on the nature or monetary value of key incentive actions. The strength of these data are in the large number of records (submitted plans), the diversity of programs and settings, the derivation of employee travel from a 5-day work week cycle, and the ability to compare the same employer over time. Nevertheless, the nature of the data makes it difficult to assess the effects of individual TDM strategies through statistical methods like multiple regression.

A principal reason for this difficulty is the inability to construct a framework around those key determinants of travel choice that are largely peculiar to the individual—such elements as trip length, availability and quality of travel alternatives like transit, nature of occupation, and even income and auto ownership. With the regulatory program data, the conceptual framework must be limited to analyzing changes in aggregate employer vehicle trip rate in relation only to the identified strategies in the trip reduction plan.

In response, the researchers opted for a different analytic approach, based on the neural network concept. Neural networks are described as "a group of highly interconnected and relatively simple computational units" (representing a structure of links and nodes). "Each of these computational units performs processing of its inputs to produce a single output. The neural network connects the output of each unit to the inputs of many other units through different weights." The process of calibrating the different units and paths is characterized as "learning," in the context of "training," in which one of several learning techniques is used to modify the weights in an orderly fashion. Since it is not the purpose of this summary to appraise the theory or accuracy of the neural network approach, the reader with an interest in better understanding this approach is advised to consult an authoritative source, starting with the project report (CUTR, 2004). This discussion will focus primarily on the findings from the CUTR application.

Standard linear regression models were used by CUTR in an early exercise to sort through and rank the relative importance of the numerous incentive measures. Because many measures were found to be quite similar, it was decided to group them into 12 categories, consisting of the following (CUTR, 2004):

- Facilities and Amenities: Passenger loading areas, facility improvements, preferential parking areas, bike racks and lockers, showers, and changing facilities.

- Guaranteed Ride Home: TMA provided program, company vehicle use, emergency guaranteed ride, rental car guaranteed trip, and taxi guaranteed trip.

- Flexible Schedules: Flextime for ridesharers including work shifts and grace periods.

- Marketing Programs: Information center, transportation fairs, focus groups, posted materials, new-hire orientation, personal communication, company recognition, special interest clubs, TMA membership, written materials, and zip code meetings.

- Rideshare Matching: Regional commuter matching agency and employer-based matching system.

- Financial Incentives: Transportation allowances, walk or bike-to-work subsidies, carpooling subsidies, and other direct financial subsidies.

- Parking Management: Increased parking fees for drive-alone commuters and subsidized parking fees for rideshare units.

- Telecommuting and Telework: Work at home and work at satellite center.

- Compressed Work Weeks: 9/80, 4/40, 3/36, or any related arrangement.

- On-Site Services: On-site childcare, cafeteria, ATMs, postal facility, fitness center, transit information, or pass sales.

- Non-Financial Incentives: Auto services (fuel, oil, tune-up); gift certificates; free meals; catalogue points; time off with pay; drawings; and awards.

- Commuter Tax Benefit Incentives: Introductory or ongoing transit passes or subsidies, subsidized vanpool seats, and ongoing vanpool subsidization.

The researchers used these 12 categories of strategies to sort and analyze the types of programs that were being implemented in the employer sample. They found 1,671 distinct strategy combinations among the sample plans, and out of these, identified the 50 most common applications. These are pictured in Table 19-31, in declining order of occurrence, from the most common combination—found in 1,036 plans—to the least, found in 76 plans. Together, this set of plan combinations accounted for 9,886 of all 21,267 plan records, or about 46 percent.

One feature of interest that can be observed in Table 19-31 is the frequency with which particular strategy types are employed in these most common programs. The most frequently applied strategies are shown in the leftmost column while the least frequent are on the right. The key trends shown here are the inclusion of marketing, facility amenities, rideshare matching, and guaranteed ride home in 90 percent or more of all programs. Non-financial incentives were present in 39 of the 50 programs, and on-site services were present in 33 of 50. Commuter tax benefit strategies, consisting of financial incentives that offer tax advantages (basically alternative mode subsidies) were present in a surprising 30 of 50 programs. Non-exempt financial incentives were only offered in 23 cases and parking management strategies showed up only in 1 of the 50 categories. Perhaps also surprisingly, alternative work schedule strategies—flexible work hours (13 programs), telecommuting/telework (eight programs), and CWW (16 programs)—were among the least frequently offered strategies. Overall, these findings have a basic similarity to those presented earlier in Table 19-27 from a 1992 study, supporting the assertion that marketing and other “soft” TDM strategies are the most commonly found in TDM programs, even those conceived under regulatory circumstances. The more influential “economic incentive” strategies are generally much less common.

The new Worksite Trip Reduction Model was then used to estimate the vehicle trip reduction impact of each of the 50 most common programs. To do this, the model was run parametrically, with different baseline conditions in terms of starting transit mode share and starting vehicle trip rate level.[13] Results are presented in Table 19-32, organized according to starting ranges of transit mode shares and vehicle trip rates (CUTR, 2004).

[13] Note that VTR as used in the source document stands not for vehicle trip reduction, but rather for vehicle trip rate. The vehicle trip rate in the source and in Table 19-32 is computed in the form of vehicle trips per 100 employees, and is the inverse (times 100) of Average Vehicle Ridership (AVR).

Table 19-31 CUTR Worksite Trip Reduction Model—Ranking by Frequency of Occurrence of the 50 Most Common Program Combinations

Package Number	Market-ing	Facility Amen-ities	Ride-share Matching	Guar. Ride Home	Non-Financial Incentives	On-Site Services	Comm. Tax Benefit	Financial Incentives	Comp. Work Week	Flex. Work Hours	Tele-Work	Parking Manage-ment	Total Cases
1	X	X	X	X	X	X	X	X					1,036
2	X	X	X	X	X	X	X	X		X			689
3	X	X	X	X	X	X	X						554
4	X	X	X	X	X		X	X					503
5	X	X	X	X	X	X							466
6	X		X	X	X	X	X	X					337
7	X	X	X	X	X	X				X			304
8	X	X	X	X	X	X	X	X	X				290
9	X	X	X	X	X		X						267
10	X	X	X	X		X			X				264
11	X	X	X	X			X	X					234
12	X	X	X	X	X								233
13	X	X	X	X	X	X	X			X			232
14	X	X	X	X		X	X	X					228
15	X	X	X	X	X								223
16	X	X	X	X	X	X	X	X	X	X			211
17	X	X		X	X	X	X	X					205
18	X	X	X	X	X	X	X		X				184
19	X	X	X	X	X		X	X		X			157
20	X		X	X	X		X	X					147
21	X	X	X	X	X	X			X		X		134
22	X	X	X	X	X		X			X			125
23	X	X	X										124
24	X	X	X	X	X	X		X					124
25	X	X	X	X	X	X	X		X	X			117
26	X	X	X	X		X	X	X		X			117

(continued on next page)

Table 19-31 (Continued)

Package Number	Market-ing	Facility Amen-ities	Ride-share Matching	Guar. Ride Home	Non-Financial Incentives	On-Site Services	Comm. Tax Benefit	Financial Incentives	Comp. Work Week	Flex. Work Hours	Tele-Work	Parking Manage-ment	Total Cases
27	X	X	X			X							116
28	X	X	X	X	X	X	X		X		X		115
29	X	X		X	X	X	X						113
30	X	X	X	X	X		X	X	X				111
31	X	X	X	X	X	X							111
32	X	X	X	X	X					X			108
33	X		X	X	X	X	X						107
34	X	X	X	X	X	X		X	X	X			106
35	X	X	X	X	X	X	X						106
36	X	X		X	X		X	X					105
37	X	X	X	X	X			X					101
38	X	X	X	X	X	X	X	X	X		X		96
39	X	X	X	X	X	X	X	X	X	X	X		96
40	X	X		X				X					92
41	X	X	X		X	X							89
42	X	X	X	X		X			X		X		86
43	X	X	X		X	X			X		X		81
44	X	X	X	X	X	X	X	X			X		81
45	X	X	X			X			X				80
46	X	X	X	X					X	X			78
47	X	X	X	X	X		X	X	X	X			78
48	X	X	X			X					X		78
49	X	X	X	X	X	X	X	X				X	78
50	X		X	X	X		X						76
Total	50	46	46	44	39	33	30	23	16	13	8	1	9,793

Source: CUTR (2004).

Table 19-32 CUTR Worksite Trip Reduction Model—Estimates of Vehicle Trip Rate Reductions for the 50 Most Common Employer TDM Program Packages

Package Number	Starting Transit Shares (shown as percentage ranges) and Starting Vehicle Trip Rates (*in italics* as ranges)															
	Transit Share = 0 - 5%					5 - 15%					15 - 25%			25 - 35%		35 - 45%
	100-90	*90-80*	*80-70*	*70-60*	*60-50*	*100-90*	*90-80*	*80-70*	*70-60*	*60-50*	*80-70*	*70-60*	*60-50*	*70-60*	*60-50*	*60-50*
1	-5.3	-2.9	-0.6	0.6	2.2	-6.8	-3.2	-1.5	-0.1	3.7	-3.2	-0.7	2.4	-1.9	-0.5	-1.8
2	-3.7	-1.6	0.4	2.5	-1.9	-2.6	-1.1	-0.2	1.7	0.4	-1.9	-0.1	0.9	-1.9		
3	-6.5	-3.7	-1.0	-0.1	3.1	-5.8	-4.5	-1.4	1.5	2.4	-3.5	-0.4	-0.3	-3.0	0.6	-2.1
4	-6.1	-4.2	-1.6	1.3		-3.3	-4.3	-2.2	0.3		-3.3	-2.0		-1.9		
5	-5.3	-2.1	-0.1	1.5	3.5	-4.6	-1.9	0.1	1.9	0.7	-1.6	2.0	2.3		-1.4	
6	-6.3	-3.2	-0.4	-3.0		-7.5	-3.7	-1.0	0.5		-3.5	-1.1		-2.9		
7	-4.3	-1.9	0.8	2.7	2.1	-1.8	-1.5	-0.7	2.9	6.3	-2.4	1.0	4.4			
8	-2.8	0.0	1.6	4.5	6.6		0.5	1.1	-1.1							
9	-6.8	-4.9	-2.1	0.2	1.6	-5.4	-4.5	-2.5	0.4	-1.0	-6.3	-0.8	0.2	-1.8	1.3	
10	-3.2	-0.5	1.7	3.9	4.8		-1.2	0.8	1.1	6.0	-1.0	2.0			1.5	
11	-6.4	-4.2	-1.6	1.3		-3.3	-4.3	-2.2	0.3		-3.3	-2.0		-1.9	1.5	
12	-6.9	-4.1	-1.0	1.5	1.1		-2.4	-0.2	1.8	4.1		1.3	3.3	-3.3		
13	-4.9	-2.9	-0.6	1.0	7.6		-2.3	-1.1	1.1		-2.0	-0.2		-3.1		
14	-5.7	-2.6	-0.1	1.5			-2.7	-1.4	2.1	1.3	-5.6	-1.0		-2.5		
15	-5.7	-3.7	-1.1	1.1	3.1		-3.4	-0.6	1.7	5.2	-1.7	0.4	4.2		-0.5	1.4
16	-1.5	0.6	2.5	4.3	5.9		0.5	1.4	3.7			0.4			0.8	
17	-5.8	-3.3	-2.1	-2.4	2.6		-3.9	-2.2	-1.0		-2.7	-1.4			5.3	
18	-3.1	-0.9	1.2	3.4	2.4		-1.8	0.2	2.7	4.4		3.3		-1.9		
19	-4.3	-3.4	-1.6	1.7			-1.6	-1.8	0.7			-1.0				
20	-5.7	-3.6	-2.1	-1.0			-4.4	-2.1	-1.3	1.3	-3.7	0.5				
21	-3.2	0.2	2.8	5.0	3.5		0.1	1.7	2.1			4.8			-1.8	
22	-5.5	-4.4	-3.5	-0.6			-3.7	-3.2	-0.9	1.0		-2.5	2.4			
23	-6.0	-3.1	-1.4	2.3	4.0		-4.8	-1.3	1.5	4.5		1.3			3.2	
24	-4.3	-1.4	-0.3	-0.4			-1.5	-0.2	0.4							
25	-0.9	-0.2	2.0	2.8			0.0	1.1	3.1		-0.7				3.4	
26	-4.8	1.3	1.0	0.9			-3.2	0.8	2.6	1.1	-1.6	-0.1		-3.2		

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Table 19-32 (Continued)

Package Number	Starting Transit Shares (shown as percentage ranges) and Starting Vehicle Trip Rates (*in italics* as ranges)															
	Transit Share = 0 - 5%					**5 - 15%**					**15 - 25%**			**25 - 35%**		**35 - 45%**
	100-90	***90-80***	***80-70***	***70-60***	***60-50***	***100-90***	***90-80***	***80-70***	***70-60***	***60-50***	***80-70***	***70-60***	***60-50***	***70-60***	***60-50***	***60-50***
27	-5.1	-2.7	-0.4	1.5	2.9	0.5	-2.8	-0.7	2.2		0.7		1.0		2.3	
28	-4.4	-0.6	1.8	3.1	8.8		-1.1	0.2	2.7			-0.3				
29	-6.9	-3.7	-1.2	-4.8	3.0		-3.6	-0.9	2.3	0.4	-0.8	-0.2		-2.4	-2.0	-1.6
30	-3.2	-1.6	0.9	3.7			2.0	-0.2	-1.3	3.0	-0.9	-0.3				
31	-4.3	-2.0	0.0	1.2	4.2		-1.2	1.7	1.8	4.3	-1.1	0.4	3.2	-1.4	2.1	-0.9
32	-4.8	-3.3	-1.2	0.5			-1.6	-1.4	1.9	3.3	-3.6	-0.9		-2.6		
33	-5.3	-4.1	-0.9	0.5			-3.7	0.1	0.6	4.1	-5.1	0.1	-0.2			
34	-1.7	0.3	2.7				-0.4	1.1	2.5							
35	-6.5	-2.9	0.1	0.3			-2.6	-0.9	1.6	4.8	-1.0	-0.8	3.8	-1.7		
36	-5.9	-3.5	-1.4	0.1	1.3	-7.6	-3.8	-0.3	-1.1	0.5		-1.6			1.1	
37	-4.8	-2.9	-0.5	2.3			-3.5	1.6		3.8						
38	-3.1	0.1	2.4	4.9	5.3		0.8	3.4								
39	-3.5	-1.0	2.1	1.0			-0.9	1.4	3.6					2.1		
40	-5.1	-2.1	-0.9	0.9	2.8	-2.9	-2.5		0.9						0.3	
41	-6.1	-2.4	1.0	3.2	2.5		-1.4	0.9	3.1	4.6	3.0	2.1	3.2			
42	-2.9	-0.5	2.5	4.1	4.6		-2.9	2.0	0.8							
43	-2.7	0.7	2.9				0.9	2.5			2.5	2.7				
44	-5.3	-2.1	-0.6	1.5			-3.7	0.5				0.0				
45	-2.8	0.3	0.8	6.4	-0.5		0.1	1.2	0.0				1.1		1.0	
46	-3.0	-1.5	1.3				-1.8	-1.8	1.1				8.0		2.0	
47	-2.6	-1.6	0.7	2.6	2.2		-1.1	-0.4	-2.2		-3.5					
48	-4.4	-3.1	-0.9	-2.4			-3.6	-2.8	-1.7	-1.6		-3.7	-4.6			
49	-5.5	-2.4	0.7	2.0			-3.5	-1.9	1.7	5.2	-1.2	-1.7	0.3	-1.5		
50	-6.5	-3.9	-1.9	1.0	2.1	-4.9	-4.4	-1.5	0.3	1.9	-1.1	-0.4				

Note: The vehicle trip rates shown as ranges, and also the trip rate change estimates, are in units of average vehicle trips per 100 employees.

Source: CUTR (2004).

The reason it is necessary to specify the starting conditions in this manner is because the strategy combinations in each package affect the distribution of mode choices differently depending on the starting point. For example, if an employer currently has carpooling as the dominant mode among employees using alternative modes, and the package of strategies is such that transit use is predominately encouraged, the effect would be to move some percentage of both SOV commuters and carpoolers to transit. The proportionate shifts that occur among modes depend heavily on the starting modal distribution and the corresponding vehicle trip rate. A similar approach was used in Chapter 3 of the 1993 FHWA guidebook *Implementing Effective Travel Demand Management Measures* (Comsis and ITE, 1993).

Studying the vehicle trip reduction estimates in Table 19-32 suggests in general that any given program of strategies starting with a lower initial vehicle trip rate will normally have a lesser trip reduction impact than if it were to start with a higher vehicle trip rate. In other words, given the same set of TDM strategies, employers whose starting vehicle trip rate is already down in the 80-70 vehicle trips per 100 employees range will see less additional trip reduction than an employer whose starting vehicle trip rate is in the 100-90 range. The same is more-or-less true of higher starting transit mode shares, as it would appear that many of these strategies may appeal more to potential carpool/vanpool users than to potential transit users, and may even begin to lure some employees away from transit. At the extreme, the effect of the given TDM program may even be to begin increasing vehicle trip making through non-optimal modal shifts. Such results are reflected in the non-negative vehicle trip rate change entries in Table 19-32.

The results shown in Table 19-32 have been abstracted from Chapter 5 of the CUTR model report (CUTR, 2004), and should be taken as illustrative of the model's behavior in forecasting the effects of typical TDM program packages over common background conditions as might be encountered in the field. For actual user applications, the model is accessible via the internet at http://www.nctr.usf.edu/worksite, allowing the user to input his/her own current conditions and to test combinations of TDM strategies on reducing their vehicle trip rate.

To illustrate the nature and sensitivity of the model, the Handbook authors executed a series of runs for a hypothetical employer of 100 employees, where as a starting condition 86 percent of employees drive alone, 2 percent take transit, 10 percent rideshare, and the remaining 2 percent bike or walk. These conditions correspond to a starting vehicle trip rate of 90.6. Using these conditions, the authors investigated the trip reduction impact which would result from the application of each of the 12 primary strategy groups—first individually, and then each paired with each of the others. The results of this exercise are shown in Table 19-33 in terms of the percentage vehicle trip reduction from the starting vehicle trip rate base of 90.6.

While readers will want to study the results in the table and develop their own conclusions, the following general observations are offered on the nature of the estimated vehicle trip reduction (VTR) results for this particular set of strategy conditions:

- The highest-impact strategies are the commuter tax benefit incentives (5.0 percent VTR), financial incentives (4.1 percent), and facilities and amenities (4.1 percent). The lowest-impact were guaranteed ride home (1.5 percent VTR) and non-financial incentives (1.3 percent), while rideshare matching (–0.3 percent) and on-site services (–0.7 percent) were projected to actually increase vehicle trips for this particular set of starting conditions.

Table 19-33 Vehicle Trip Reduction Estimates for TDM Programs and Combinations Based on CUTR TDM Model

	VTR Estimated Starting with a Base of 90.6 Vehicle Trips per 100 Employees											
TDM Program Type	**F&A**	**GRH**	**FLEX**	**MRKT**	**RSMP**	**FIN**	**PMT**	**TELE**	**CWW**	**ONS**	**NONF**	**CTB**
Facilities & Amenities	4.1%											
Guaranteed Ride Home	3.1%	1.5%										
Flexible Schedules	3.5%	2.1%	2.5%									
Marketing	3.3%	3.2%	3.4%	3.5%								
Rideshare Matching	0.8%	-0.9%	0.1%	2.0%	-0.3%							
Financial Incentives	4.9%	3.7%	4.0%	4.9%	1.1%	4.1%						
Parking Management	4.2%	1.7%	2.8%	4.5%	0.2%	4.8%	3.0%					
Telecommuting	3.5%	1.8%	1.7%	2.4%	-0.4%	2.3%	2.1%	1.9%				
Comp. Work Week	5.7%	1.8%	2.9%	1.7%	0.8%	3.2%	2.9%	2.5%	3.8%			
On-Site Services	2.1%	-0.8%	1.1%	1.3%	-3.2%	1.6%	-0.3%	0.4%	-0.1%	-0.7%		
Non-Financial Incent's.	3.1%	1.0%	1.3%	2.6%	-1.5%	3.0%	2.3%	0.1%	1.3%	-1.3%	1.3%	
Commuter Tax Benefit Incentives	6.8%	3.6%	4.3%	2.7%	2.4%	4.7%	4.4%	4.2%	7.0%	2.6%	2.4%	5.0%

Notes: Hypothetical employer of 100 employees, with starting employee mode shares of 86 percent drive alone, 10 percent rideshare, 2 percent transit, and 2 percent bike or walk (90.6 Vehicle Trips per 100 Employees).

A negative value indicates that the program or combination will actually increase vehicle travel under the conditions assumed.

Source: Illustrative model application prepared by the Handbook authors utilizing the CUTR Worksite Trip Reduction Model available at http://www.nctr.usf.edu/worksite (now superseded — see Footnote 14). Center for Urban Transportation Research. (Website accessed Winter/Spring 2007.)

- The strongest two-category combinations were commuter tax benefits teamed with facilities and amenities (6.8 percent VTR) and commuter tax benefits teamed with CWW (7.0 percent). The poorest results seem to come when on-site services are combined with rideshare matching (–3.2 percent VTR), non-financial incentives are paired with rideshare matching (–1.5 percent), and non-financial incentives are teamed with on-site services (–1.3 percent). Such seeming anomalies often occur using models when complex modal tradeoffs are occurring in the calculations. In this particular test, however, a combination like rideshare matching with on-site services might be expected to lead to a more favorable result, given that the starting conditions are favorable to ridesharing over transit.

- There are only eight cases in the 66 pairs pictured in Table 19-33 where the pairing actually results in a positive, or at least somewhat synergistic effect, i.e., the combination of the two strategies leads to a trip reduction impact that is larger than either strategy individually. These pairings are: commuter tax benefits teamed with CWW (7.0 percent VTR versus 5.0 percent and 3.8 percent individually) or with facilities and amenities (6.8 percent VTR versus 5.0 percent and 4.1 percent individually), CWW with facilities and amenities (5.7 percent versus 3.8 percent and 4.1 percent individually), parking management with facilities and amenities (4.2 percent VTR versus 3.0 percent and 4.1 percent individually) or with marketing (4.5 percent VTR versus 3.0 percent and 3.5 percent individually) or with financial incentives (4.8 percent VTR versus 3.0 percent and 4.1 percent individually), and financial incentives with facilities and amenities (4.9 percent VTR versus 4.1 percent and 4.1 percent individually) or with marketing (4.9 percent VTR versus 4.1 percent and 3.5 percent individually). In none of these scenarios is the synergy sufficient that the estimated trip reduction effect in combination is greater than the sum of the separately applied individual strategies.

The Worksite Trip Reduction Model would appear to be an excellent start toward a set of tools that can help TDM planners make sense of the vast number of strategies available to them. In addition to being easy to use, a very appealing aspect of this new tool is that it does not seem to generate unrealistic estimates of trip reduction. The predicted reductions are generally on the order of 3 to 6 percent. Reduction estimates of this magnitude compare more realistically with the typical employment site results seen within large area-wide programs than do the 15 percent to 30 percent reductions seen in the 82-program sample. It should once again be stressed that the 82 examples include many exemplary programs, and that that group should not in any way be construed as typical of what might be realized in a large area-wide regulatory program.[14]

Practitioners are urged to apply caution and common sense to any model projection, whether it be the two models featured in this subsection, or the FHWA TDM Evaluation Model, or the U.S. Environmental Protection Agency (EPA) COMMUTER Model introduced later in the "Additional Resources" section. Empirical case studies such as those presented in this chapter, or contained in a number of the recommended resources, always serve as a good way of cross-checking a TDM program's potential impact.

International Experience

Outside the United States, interest in TDM has been particularly high in the Netherlands and in the United Kingdom. A study prepared for the British Department for Transport (DfT), *Smarter*

[14] During the timeframe of the Chapter 19 review and publication process, CUTR issued an update to the Worksite Trip Reduction model, now renamed TRIMMS© (Concas and Winters, 2009). See the "Additional Resources" section for additional information.

Choices—Changing the Way We Travel (Cairns et al., 2002), provides a summary of TDM experience in those two venues. Key studies and findings from the experience reviewed are summarized in the following section.

Making Travel Plans Work[15]

This analysis and report was originally prepared for the DfT in 2002 by Cairns, Davis, Newson, and Swiderska of ESRC Transport Studies Unit UCL, and Adrian Davis Associates. It represented the biggest study of British workplace travel plans to date and presents results based on an analysis of best practice at 20 organizations employing over 69,000 employees. These cases represented a range of public and private organizations, all of which were selected as examples of good (not average) practice. Taken overall, the 20 organizations had reduced the number of cars driven to work by 14 for every 100 staff, representing an average reduction of 18 percent in the proportion of commute trips by car driver. On average, the organizations had doubled the proportion of staff commuting by bus, train, cycling, and walking, and car sharing (carpooling) had also been reasonably successful.

A study of factors that made some travel plans more successful than others produced very few generalizations that could be made. All travel plans had involved real changes to employee travel options, so it was not possible to assess the effects of plans that focused on awareness-raising only. The one factor that did emerge was parking. For the 13 travel plans that had addressed parking, either by restricting supply, introducing charges, or providing incentive payments to those giving up a parking space, the proportion of commute trips made as car driver was reduced by 24 percent, compared to 10 percent for those plans that had not addressed parking (Cairns et al., 2002).

Effective TDM at Worksites in the Netherlands and the United States

This study, performed by Organisational Coaching and Schreffler in 1996, compared 20 paired case studies from the Netherlands and the United States. The organizations examined included a large hospital, a large manufacturer, a government organization or utility, a bank, an insurance or telecommunications organization, a major university, an airport, a consultancy firm, and a smaller employer with less than 250 employees. Again, examples chosen were all considered to be success stories. Results showed remarkable similarity across the two sets of case studies, with the programs in the United States revealing VTR rates in a range of 6 percent to 49 percent, with an average of 19 percent, while those in the Netherlands had reductions in vehicle kilometers of travel ranging from 6 percent to 32 percent, averaging 20 percent (Cairns et al., 2002).

Netherlands Ministry of Transport Study

A 1998 Dutch study by Ligtermoet included a review of new results from 40 organizations in the Netherlands plus other Dutch data. Analysis showed that plans with "basic" measures (such as car-sharing schemes) achieved vehicle kilometer reductions of 6 to 8 percent, while those with "luxury" measures (such as company buses) or "push" measures (such as parking management) achieved reductions in the range of 15 to 20 percent. This led to the conclusion that plans combining both "carrots and sticks" are the most effective (Cairns et al., 2002).

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[15] A "travel plan" is the equivalent of what is known in the United States as a Transportation Management Plan (TMP) (Enoch and Zhang, 2008). United Kingdom experience with travel plan employer participation rates is included in the "Site- Versus System-Level Impacts" subsection which follows.

Travel Planning in the Randstad: An Evaluation Based on ReMOVE

This review of Dutch travel plans by Touwen in 1999 concluded that travel plans consisting of communication/marketing measures, basic measures such as carpooling and cycle leasing, and organizational measures such as flextime achieved an average reduction of 8 percent in vehicle kilometers traveled. However, if luxury measures or disincentive measures were added, the average reduction was about 20 percent (Cairns et al., 2002).

Smarter Choices—Changing the Way We Travel

This study by the Cairns organization itself tracked and reported on its own selection of 26 workplace travel plan case studies from locations in Birmingham, Bristol, Buckinghamshire, Cambridgeshire, Merseyside, Nottingham, and York. Although the study reports trip reductions, the strategies employed were not specified. The report seems to have been more oriented to exploring the process by which the programs were engineered, their costs, and projections of their possible effects at different levels of geographic resolution (Cairns et al., 2002).

Site- Versus System-Level Impacts

The vast majority of travel demand management effectiveness data presented up to this point in Chapter 19 has been measured and analyzed at the site level, providing findings about TDM impact on travel to and from particular offices, campuses, and other specific employment and institutional sites engaging in specific sets of TDM strategies. Most of this data addresses only the effect on travel produced by the journey to and from work or school. Some results have been presented at a program level, such as employee or student pass programs facilitated by public transportation agencies but implemented at the site level in conjunction with individual employers or institutions.

This focus on site-level work-commute-trip impacts is consistent with the scope of this chapter, which (in accord with its title) addresses employer and institutional TDM strategies and not programs more or less independent of employers such as residence-based programs or area-wide agency programs. Examples of broader agency-implemented programs are wide-area transit improvements and regional rideshare matching programs.

Indeed, a number of important objectives associated with TDM apply at the site level, including employee and through-traffic congestion mitigation at site access points, site traffic pollutant emissions reduction, parking facility needs reduction, and employee benefits. Nevertheless, the question remains about the broader effects of site-based TDM on all employees within an urban sector, on overall peak-period area street traffic, on major transportation facilities, and on regional vehicle trip making and VMT. Information about such broader effects would be useful for a quantitative understanding of TDM efficacy in addressing objectives such as regional transportation facility congestion mitigation, energy conservation, improved regional air quality, and reduction in global warming gas emissions.

Overview of System-Level Impact Relationships

As one moves from the site level toward the broader area level or regional traffic facility level the following stages of impact dissipation apply (Pratt, 1990):

Stage 1. A leveling out of effects among differing participating employer and institutional scenarios, reflecting various types and sizes of employers and TDM programs, and averaging out of high-effectiveness and lower-effectiveness programs.

Stage 2. Dissipation of work-trip effects as average site-level effects are mixed with the unaffected commuting associated with non-participating employers.

Stage 3. Additional trip-reduction dissipation as work-commute trips are mixed in with non-work site-generated travel produced by both participating and non-participating employers and institutions along with other interspersed land uses.

Stage 4. Further leveling-out of impacts as locally generated trips and traffic are intermixed with other trips and traffic. On transit systems and local area streets only intra-regional through movements will normally be of significance, but on regional highway facilities, other traffic will include intercity travel.

These stages are referred back to, often with examples, in the discussion which follows.

Impacts at the site level vary according to employer type, most notably whether an office, retail, or industrial employer is involved, and size of employer. Although most studies have found no significant relationship among TDM program effectiveness levels for large, medium, and medium-small employers, it has generally been presumed that fewer TDM actions are workable for firms of less than 100 employees (Comsis and ITE, 1993). According to 2004 U.S. Census data, 36 percent of all employees work for firms with less than 100 employees (U.S. Census, 2007).[16]

Degree of Employer Participation

Site-level TDM impacts, even once averages are calculated (Stage 1 dissipation as identified above), apply only to employers actually participating in the employer-dependent TDM strategies. These impacts are diluted, on an employment-area level, by non-participating employers (Stage 2 above).

The degree of employer participation or non-participation is heavily impacted by the regulatory environment. Where no legal requirement compels participation, employer involvement is voluntary, and participation generally reflects the employer's self-interest. Where a legal requirement for TDM program participation derives from the administration of land use and zoning regulations, the requirement may directly apply only to new sites and not to pre-existing employment. Full mandatory participation, such as applied in Southern California's air quality Regulation XV program, does not really apply to all employers. "Full mandatory" participation typically applies only to employers of 100 (sometimes 50) or more employees. Further background on effects of employer type and regulatory influences is provided in the "Underlying Traveler Response Factors" section under "Voluntary Versus Regulatory Employer Motivation" and "Characteristics of Employer."

Degree of employer participation has been approximated in some analyses by means of "employer participation rate" averages. Evaluating degree of site-level impact dilution by non-participating employers requires associating employer subgroups with their average employer participation rates (Comsis and ITE, 1993). Table 19-34 gives default experience-based employer participation rates for voluntary employer participation from the "FHWA TDM Evaluation Model" and indicates their empirical and/or judgmental basis. As can be seen, these rates were based on very limited expe-

[16] National employment statistics such as this provide only an approximate indication of employment site size distributions and almost certainly understate the prevalence of smaller-size establishments. Self-employed persons without payroll are excluded, and large employers may have secondary places of business which, from an employee transportation perspective, are similar to small businesses.

riential data and considerable extrapolation therefrom. (See the “Additional Resources” section for more on the FHWA TDM Evaluation Model.)

Empirical voluntary employer participation rates have been reported in the aggregate for the United Kingdom. Termed “level of travel plan take-up,” the observed rates apply to all degrees of travel plan scope and intensity. (The United States equivalent of a travel plan is a Transportation Management Plan, or TMP.) The concept of the travel plan arrived in the United Kingdom from the United States in the mid-1990s, after first being taken up by the Netherlands. The U.K. Department of Environment, Transport, and the Regions (DETR) is pursuing “widespread voluntary take-up of travel plans” according to a 1998 white paper.

The highest U.K. employer participation rates have been observed among local government entities. In 1997/1998, 3 percent had TMPs on a permanent basis and another 4 percent had TMPs on a pilot or trial basis, for a total of 7 percent participation. The total had risen to 24 percent by 2001 and 62 percent by 2006. Participation rates are observed to be much more modest in the U.K. private sector. Of firms with 100 or more employees, 4 percent had permanent TMPs in 1997/1998, with no data available on pilot or trial TMPs. The total of permanent and experimental TMPs equated to a 7 percent participation rate in 2001 and rose to 11 percent participation in 2006. Small businesses of less than 100 employees have been found to be relatively neglected. Circa 2000, only 19 percent of small businesses were even aware of the travel plan concept (Enoch and Zhang, 2008).

Table 19-34 Experience-Based Voluntary Employer TDM Participation Rates

Program Type	Voluntary Employer Participation Rate[a]	Basis of Value (Rates Observed)	Sources of Observed Participation Rate Values
Carpool Programs	37% for firms with 100 or more employees 4% for firms with less than 100 employees	Average for firms in Atlanta, Cincinnati, Houston, and Seattle encompassed by Ridesharing Demonstration Program[b]	Transportation Research Center, Urban Mass Transportation Administration, "National Ridesharing Demonstration Program: Comparative Evaluation Report." Cambridge, MA (1985).
Variable Work Hours	Same as carpool programs (deemed to fit logically with the observed values, which weren't available by firm size)	Weighted average of 6% for six North American regions and 28% for six CBDs (16% weighted average overall)	Pratt and Copple (1981)
Other Non-Monetary TDM	Same as carpool programs	None available	None available
Transit Fare Incentives	7% for firms with 100 or more employees 1% for firms with less than 100 employees	Taken at 20% of carpool program rates based on comparisons available for Boston[c, d]	Pratt and Copple (1981)
Other Monetary TDM	Same as transit fare incentives	None available	None available

Notes: [a] As utilized in the FHWA TDM Evaluation Model.

[b] The National Ridesharing Demonstration Program report indicated a higher overall voluntary employer participation rate for minimal-effort, low-impact carpool programs but without any breakout by firm size.

[c] Of Boston area firms selling transit passes to their employees, 7.6 percent subsidized them. This was 20 percent of the carpool program employer participation rate for firms with over 100 employees. The number of firms subsidizing transit passes (56) was also 20 percent of the number of firms with variable work hours programs (285).

[d] Programs such as Denver's Eco Pass and Seattle's FlexPass (see "Response by Type of Strategy" — "Changes in Fare Categories" — "Unlimited Travel Pass Partnerships" in Chapter 12, "Transit Pricing and Fares") offer the potential for updated participation rate calculations but none such have been encountered.

Source: Pratt (1992).

Intermediate Effects of Dissipation

Continuing briefly with U.K. experience, it is of interest that two estimates have been prepared of national-level commute trip vehicle travel reductions attributable to travel plan implementation. DETR research published in 2004 produced estimates that commute trip vehicle kilometers of travel (VKT) reductions in the range of 0.4 to 3.3 percent had been achieved. This finding is complemented by a slightly earlier independent estimate that the travel-plan-attributable reduction in commute VKT had possibly been 1.143 billion kilometers per year, or 0.74 percent of the auto commute total (Enoch and Zhang, 2008). These U.K. estimates address the dissipation in Stages 1 and 2—and to a certain extent Stage 4—as described above, but not the Stage 3 intermixing of commute travel with travel for all other trip purposes.

In the United States, as of the early 1990s, results for a number of programs that had taken an area-wide approach to TDM were not suggestive that TDM was an effective broad-area strategy. Many of these efforts were associated with TMAs that had largely depended on voluntary cooperation by employers or developers and lacked the technical guidance and legal clout to move beyond a marketing-based approach. Lacking decisive actions, these programs had not proven to be instruments of significant change (Comsis and ITE, 1993).

During a somewhat longer contemporary time frame, California saw widespread adoption of mandatory employer-based trip reduction, implemented primarily through city and county ordinances and air quality district rules. The objectives were congestion mitigation or pollutant emission reduction. These programs were terminated or drastically altered by California legislation signed in January 1996 that prohibited mandatory programs. The reported results of these mandatory trip-reduction programs do not encompass the full sequence of employer-based TDM impact dissipation, but do provide a look at the work-commute-trip reduction averages achieved by all non-exempted firms across whole political jurisdictions (Stage 1 dissipation as identified earlier). Exempt firms were typically those with fewer than 100 employees (Dill, 1998).

Table 19-35 lists 13 such programs, including two from outside California, and indicates the drive-alone mode share and reduction averages achieved. Drive-alone rate reductions somewhat overstate vehicle trip reductions, since the carpooling alternative diminishes but does not fully erase vehicle trips. Nonetheless, they are a useful indicator. As can be seen by examination of the table, the average drive-alone work-commute reduction was 3-1/2 percentage points. The range, excluding the highest and lowest outliers, was from no effect to a 7 percentage-point drive-alone trip reduction among covered employees.

Results from SCAQMD for the 5-year period 1988–1993 provide additional information for the greater Los Angeles region. Employers with over 100 employees were required to submit plans and status annually, although somewhat longer times between plan submissions was not uncommon. Implementation of the mandatory program was gradual, and started with the region's largest employers. Data for 817 sites with 4 or more plans give an indication of average vehicle ridership (AVR) progress over time. The aggregate (weighted average) AVR for these sites was 1.196 at the time of the first plan, 1.220 for the second plan, 1.271 for the third, and 1.288 for the fourth. This equates to a 7.7 percent improvement in AVR, over a span of 3-plus years, equivalent to slightly over a 7 percent reduction in journey-to-work vehicle trips per employee.

Table 19-35 Drive-Alone Work-Commute Travel Mode Shares and Reductions with Mandatory TDM Programs

Jurisdiction	Year Plan Adopted	Time Span of Reported Data	Change in Drive-Alone Rate[a]
Menlo Park, CA	1988	1990-1993	-7%
Pleasanton, CA[b]	1984	1985-1995	+3%
Central Contra Costa Co., CA	1992	1994-1995	-3%
West Contra Costa County	1992	1994-1995	-3%
East Contra Costa County	1992	1994-1995	-1%
Contra Costa Centre (BART)	1986	1986-1990	-1%
Walnut Creek, CA	1988	1988-1990	-4%
San Ramon, CA	1989	1990-1995	-3%
Concord, CA	1985	1987-1988	0%
Northern San Mateo Co., CA	1983	1992-1994	-6%
Southern CA (SCAQMD)	1987	1989-1994	-11%
Phoenix/Maricopa Co., AZ	1988	1990-1995	-6%
Washington State	1991	1993-1995	-4%

Note: The source states: "Determining the actual impact of these programs is beyond the scope of this paper… the issue is to determine what is significant or worthwhile."

[a] Percentage-point change in drive-alone share.

[b] The focus of the Pleasanton program was on peak-congestion mitigation, more than trip reduction per se, and the program relied heavily on variable work hours measures.

Source: Dill (1998).

Looking at all 4,999 participating employment sites with valid information and two-or-more approved plans, the aggregate starting AVR was 1.205. The last reported AVRs, as of November 1993, aggregated to 1.257, up 4.3 percent. The corresponding trip reduction was 4.1 percent over the 1- to 3-plus-year time spans involved. The average commute-trip drive-alone share for the 4,999 sites decreased from 73.5 percent to 67.2 percent, a 6.3 percentage-point reduction. That shift translates into a 9.6 percent drive-alone share decline from the initial to the most current plan. It was largely attributable to increased carpooling, with the carpooling share increasing from 15.5 to 21.4 percent. Concurrently, vanpooling increased from 1.2 to 1.9 percent. The transit share increase was slight, from 4.0 to 4.3 percent. Walk and bike, together 3.0 percent, did not change. While the CWW day-off share increased from 1.3 to 1.9 percent, the telecommuting share dropped from 1.4 percent to 0.3 percent (Young and Luo, 1995).

Only 6 percent of regulated sites charged for parking. In their earlier plans, 69 percent of employers offered direct financial subsidies for alternative modes. This investment in vehicle trip reduction declined, however, to 53 percent in the last plans of the 5-year evaluation period. No more than a weak statistical relationship was found between AVR progress and site characteristics and between AVR progress and program duration. Location in the Los Angeles Central Business District (CBD) affected the mix of mode shifts, however. At the 188 CBD sites, carpool and transit shares started at around 21 to 22 percent. Carpooling increased 4 percentage points and transit increased 3 percentage points from the first-reported to the last-reported shares.

A significant negative relationship was found between AVR progress, expressed as aggregate percent gain in AVR, and the initial AVR. Of particular note was the 14 percent average *drop* in AVR for the 582 sites starting with an initial AVR of 1.5 and above (Young and Luo, 1995). The research paper does not examine possible causes of the program failure affecting the group of sites with a high AVR to start with. Clearly overall average program results, though they remained positive, were dragged down by this outcome.

The case study, "Overall TDM Program Effects over Time—Bellevue, Washington," (see this chapter's "Case Studies" section), looks at impacts of the first two stages of dissipation on employee travel mode shares. While estimated employee vehicle trip reductions at key employers were on the order of 30 percent or more in response to TDM program implementation, the overall downtown employee drive-alone commute share reductions were on the order of 10 percent over a 20-year time span. (A second data source places the reduction at 2 percent.) In response to both employer TDM and extensive public improvements to bus transit services, the corresponding transit commute share doubled (see case study for sources).

End Results of Dissipation

Only two fully or partially empirical studies addressing all four stages of dissipation of TDM program effects, as identified above under "Overview of System-Level Impact Relationships," have been encountered. In the fully empirical study, dissipation as one moves outward from the involved employment area—primarily through intermixing with other travel (Stages 3 and 4 dissipation)—was measured in the early 1970s for the introduction of variable work hours for Canadian government workers in Ottawa, Canada. The relative impacts are highly illustrative even though the specific traffic-peaking reductions obtained are uniquely large because of the single-employer dominance of the national government in downtown Ottawa.

The primary effectiveness measure in the Ottawa study, given that trip-reduction measures were not part of the variable work hours program, was percentage reduction in the peak-hour to peak-period traffic ratio. The construct of this measure was such that it was equal to the percentage reduction in peak-hour traffic in those instances where there was no change in peak-period traffic volumes. It was applied to both street traffic volumes and transit ridership.

The street traffic effect was measured in the PM peak period. The reduction in the peak-hour to peak-period auto traffic ratio was 21.6 percent as measured at parking lots. Non-work travel and other traffic intermixing effects were such that the corresponding reductions as measured at the central Ottawa Cordon and at the Ottawa River screenline dropped to 10.2 and 5.7 percent, respectively. Corresponding PM transit ridership peaking reductions were 23.7 percent for government employee transit riders, as measured at their workplace, down to 19.2 percent for all peak-direction transit riders at the central Ottawa Cordon. Peaking reductions for AM peak-period transit riders were 16.9 percent at the workplace and 8.4 percent at the central Ottawa Cordon (Safavian and McLean, 1975).

There is no other known fully empirical research on system-level effects of TDM. It is doubtful that broad-area traffic volume reduction impacts of typical site-level employee-trip-reduction programs are amenable to direct field measurement of traffic volume changes given the potential for confounding effects ranging from land development to shifts in economic conditions. Successful empirical measurement requires rigorous surveys of person- and vehicle-trip making, planned sufficiently in advance of initial program implementation, and paired with good luck that brings minimal or reliably quantifiable exogenous impacts.

The partially empirical study encountered is particularly useful in that the methodology not only covers—in effect—all four stages of dissipation but goes further, estimating congestion and emissions reduction effects. By so doing, it addresses the importance of even modest traffic reductions to congestion mitigation.

The subject of the partially empirical study was an 8.6-mile north-south stretch of I-5, centered on downtown Seattle, along with the employers along the way and their CTR programs. Employers within an approximately 3.6-mile band were considered, including all located in the Seattle CBD. Coverage included 189 employers with CTR programs. The empirical component of the study included the before and after trip reduction strategies of each employer with a CTR program, participation rates for the nearly 63,000 employees involved, and commute trip origin-destination data. The modeled component started with the estimation of the corresponding VTRs, done using EPA's COMMUTER Model (see "Additional Resources"—"Analytic Tools"). Non-participating employers were accounted for through the non-inclusion of any trip-reduction effects for employers without included CTR programs. The vehicle trips eliminated were then assigned to an already calibrated and evaluated current-conditions CORSIM microsimulation traffic representation of the corridor, to assess what conditions would be without CTR program TDM. For simplicity and considering their function, the analysis treated the I-5 reversible express lanes as ramps and otherwise excluded them from the analysis (Georggi et al., 2007).

Not all TDM strategies in place were credited in the analysis, again for simplicity. The included strategies were alternative work schedules, employer TDM support strategies, travel cost changes, and flexible work hours. The estimated VTR average for the employers with CTR programs was between 11.3 and 14.2 percent. The higher number assumed observed parking charges were all attributable to the CTR programs, while the lower number took into account that the basic charges might have existed anyway (but without carpool/vanpool discounts). The higher estimate was adopted for the extended analysis. Note that these average VTR estimates correspond to Stage 1 dissipation of the four stages outlined earlier.

The completed traffic analysis (corresponding to Stage 4 dissipation) found a difference in peak period traffic volume on study corridor I-5 on-and-off-ramps averaging about 4 percent. The largest peak-direction changes on any individual ramp were about 50 to 55 percent depending on the peak period (Georggi et al., 2007). Corresponding performance measure effects, more substantial than the volume changes might at first glance imply, are covered in the "Cost-Effectiveness" and "Energy and Environmental Relationships" subsections to follow.

In addition to these two empirically-based studies, a few forecasts or hypothetical estimates have been made of system-level effects inclusive of all four stages of impact dissipation. In the mid-1980s, for example, a precursor of the FHWA TDM Evaluation Model and traffic assignment (simulation) techniques was used to estimate the effect of potential Minneapolis airport-area TDM on adjacent I-494 traffic volumes. The "Low Scenario," employing modest TDM measures in combination with assumption of mixed-use land development, was forecast to offer a 7 to 11 percent vehicle-trip reduction, compared to conventional development with no TDM, as measured at participating employer/land-development sites. After accounting for all types of impact dissipation, this was projected to equate to a 2 percent average workplace vehicle-trip reduction, including both new and old development, and a 1 percent reduction in peak traffic on the I-494 study-area segment. The "High Scenario," employing mandatory TDM with strong parking management along with mixed-use development, was estimated to offer an 8 to 27 percent VTR at participating sites, a 6 percent average workplace VTR, and a 2 percent peak-traffic reduction on the adjacent I-494 segment (Pratt, 1990).[17] Insofar as this study only looked at suburban freeway mainline volumes and the Seattle I-5 analysis described immediately above reported only urban freeway ramp volumes, direct comparison is not possible, but the estimated traffic outcomes appear to be generally compatible.

Note that the Minneapolis airport-area "High Scenario" key employer and average workplace impact estimates are in the same ballpark as the downtown Bellevue empirical results now available (see the Bellevue case study). On the other hand, the Bellevue program is a uniquely successful example and is outlying-downtown-oriented. Actual results for voluntary TDM programs in spread-out suburban employment areas would likely be in the realm of the Minneapolis I-494 "Low Scenario" estimates. It is also of interest to note that the Minneapolis I-494 "High Scenario" estimate for facility-level traffic reduction of 2 percent is of the same order of magnitude, although somewhat lower than, the estimates by Kenneth Orski of a theoretically achievable 2 to 3 percent decrease in regional vehicle trips and 3 to 4 percent decrease in regional vehicle miles of travel (VMT) (Orski, 1993). These estimates were presented earlier, at the end of the "Voluntary Versus Regulatory Employer Motivation" discussion within the "Underlying Traveler Response Factors" section.

As of this writing, Washington is one of very few states that currently have strong Commute Trip Reduction laws or the equivalent. State officials have noted that "Washington and Oregon are the only states where the percentage of people driving alone to work decreased between 1990 and 2000." Oregon has similar regulations plus urban growth boundaries. In Washington State the 1990–2000 drive-alone share reduction was 0.6 percentage points, from 73.9 percent to 73.3 percent, an 0.8 percent decline. Nationwide, the U.S. drive-alone share for commuting increased by 3.4 percent (Washington State Department of Transportation, 2007). Although these observations cannot demonstrate causality, they are suggestive of a broad-scale TDM, transportation investment and operations, and land use public policy impact. Comparing the Washington State 1990–2000 drive-alone share reduction with the national drive-alone share increase suggests that this combined impact may, over a decade, be on the order of a 4 percent drive-alone share reduction/dampening under favorable mandatory regulation conditions.

Cost-Effectiveness

Numerous studies in the 1990s investigated the cost-effectiveness of TDM approaches for reducing vehicle travel and also emissions. A major motivation in these studies was the outcry from employers in Southern California who complained about substantial costs to implement trip reduction programs under the requirement of Regulation XV, made in the context of growing evidence that the program was falling short of its goals in achieving trip-reduction targets. A 1993 study by Ernst & Young caused widespread controversy when it concluded that employers participating in Regulation XV were realizing an annual expense per employee of $105 for that participation, with a cost per trip reduced of $3,000 per year.

In a challenge of these findings, contrary evidence from other studies was presented, including Chicago ($31.42 per employee per year); San Diego ($26.15); Commuter Transportation Services

[17] The original estimates included effects of workplace-based variable work hours programs and facility-based TSM measures such as freeway metering/bypass lanes and HOV lanes. These effects are not included here for clarity of presentation.

($57); UCLA/USC ($31); TCRP ($14.70); Maricopa County, Arizona ($8); Pima County, Arizona ($18); and Washington State ($9). From these data it was concluded that a more appropriate estimate of cost per employee would be in the $8 to $57 range, with an average of $24 (Schreffler, 1996). An earlier study at University of California, Berkeley tended to reinforce the latter findings with an average cost of $31 per employee per year and a median cost of $20, although the objective of the University of California, Berkeley study had been to demonstrate that other transportation management measures—such as pricing, land use density, and a broader range of alternatives—would be generally more cost-effective than regulatory TDM (Wachs, 1993).

In Part III (Section 3.4) of the 1993 FHWA report, *Implementing Effective Travel Demand Management Measures,* an assessment is made in circa 1991–1992 dollars of the cost and cost-effectiveness of 22 employer programs researched for the study. Parking was charged for outright at 12 of these 22 organizations. These 12 plus another six of the programs included incentives and/or disincentives of some sort.

The analysis looked at direct costs associated with administering the program, plus any subsidies or costs of providing services, and then also estimated cost savings. Savings were determined as either revenues generated by the program (such as parking fees) or costs averted, particularly avoided costs related to employee parking. Only situations where the employer was paying a separate, definable cost for parking were considered to be avoidable.

Over the sample of 22 employers, the direct cost per daily one-way vehicle trip reduced ranged from $0 to $6.75, with an average of $1.22 (weighted by trips). Cost savings per trip reduced ranged from $0 to $6.21, with a weighted average of $1.94. Net cost per trip reduced, or direct cost minus cost savings, ranged from $4.99 to –$3.32, with a weighted average of –$0.72.[18] If this net cost were presented in terms of the entire employee base (perhaps a better measure of the cost impact on an employer) the range was from $1.81 to –$2.01 per employee, with an average of –$0.24 for the overall sample.

The lesson taken from this analysis was that employer TDM programs that incorporate financial incentives and disincentives—most particularly including the availability and price of parking—are not only the most effective in reducing vehicle trips, but have the lowest cost per employee and per trip reduced of all programs. Indeed, as just presented, the net costs per trip and per employee were each found to be negative on average (Comsis and ITE, 1993). This finding may also partially explain the high cost per employee and per trip in the Ernst & Young study. The great majority of programs that were in place and examined in that study were support-type programs that did not use incentives and disincentives (Schreffler, 1996).

Similar findings about the effect of different program types were derived from the results of a survey of 49 employers in the TCRP Project B-4 study (Comsis, 1994). In this project, a framework was used that categorized employer programs into four groupings: programs that were essentially support measures, programs incorporating services, programs built on incentives and disincentives, and programs combining services with incentives/disincentives. Table 19-36 shows the cost-effectiveness results from this analysis.

[18] The trip cost data presented here in the first half of this paragraph are the only known instance in this chapter of performance data dimensioned in one-way trips. The findings should be multiplied by two before comparing with other information in the chapter on cost per trip reduced.

Table 19-36 Cost-Effectiveness of Four Types of TDM Programs

			Annual Cost per Employee		Cost per Daily Trip Reduced	
Type Program	**Number**	**VTR**	**Direct**	**Net**	**Direct** [a]	**Net** [a]
Support	6	-1.4% [b]	$13.92	$13.92	$0.62	$0.62
Services	5	8.5%	$29.16	$29.16	$1.49	$1.49
Incentives	27	16.3%	$13.46	-$111.47	$0.37	-$1.36
Services and Incentives	11	24.5%	$92.94	-$24.77	$1.35	-$0.63
All	49	15.3%	$32.96	-$62.30	$0.75	-$0.78

Notes: [a] Computed only for programs with a positive trip reduction.

[b] A negative VTR implies that the sample program(s) had vehicle trip rates that were actually greater than the average from the surrounding area with which they were compared.

Source: Comsis (1994), with table corrections by the Handbook authors, derived on the basis of the disaggregated data in the source document.

As the level of program intensity grows from support to full-fledged services-plus-incentives, the average VTR also increases. This increase runs from the seemingly odd result of an average computed *gain* in vehicle trips for the support programs of a –1.4 percent VTR (see Note *b* in Table 19-36) on up to a reduction of 24.5 percent for the service and incentive programs. Looking at costs, support programs cost the employer an average of $13.92 per employee per year, while service-based programs, which have a higher VTR impact, cost $29.16 per employee per year. Incentive/disincentive-based programs cost the employer $13.46 per employee per year, less than one-half the cost of the services programs but reducing twice the rate of trips. Service/incentive programs cost $92.94 per year per employee, the highest unit cost, attributable to the extensive nature of the programs—especially the services and subsidies. These programs, however, also achieve the highest average trip reduction, at 24.5 percent.

The picture changes sharply when avoided costs are factored in. When this is done, the support and the services programs change imperceptibly, since they haven't reduced trips substantially, and because parking was not found to be a problem at these employers. However, the incentive/disincentive programs show an average net cost savings of $111.47 per employee per year. The service/incentive programs—comparatively expensive on a direct cost basis—become financially attractive with avoidable cost savings factored in, providing a net cost savings of $24.77 per employee per year.

The relationships change somewhat when costs are examined on a per-trip basis. Support programs average $0.62 in direct cost per daily vehicle trip reduced (a cost per trip was only calculated for those programs with a positive trip reduction). Service programs average $1.49 per daily vehicle trip reduced, again about double the cost of the support programs. Incentive programs realize a cost of $0.37 per trip, lower than the others, while service/incentive programs cost $1.35 per trip. The average direct cost per daily vehicle trip reduced is $0.75 for all programs, a surprisingly low number. When net costs are computed on a per-trip basis, the two high-yield program types, incentive and service/incentive, emerge as the most cost effective, with cost savings of $1.36 and $0.63 per daily vehicle trip reduced, respectively. In contrast, neither the support nor the services programs had avoidable costs to claim, and hence their net cost per trip reduced is the same as the direct cost per trip (Comsis, 1994).

A "Trip Reduction Performance Program" sponsored by the Washington State Department of Transportation (WSDOT) offers a window into 2005–2009 trip reduction costs under the state's CTR regulations. Under this program entities ranging from employers to agencies contract with WSDOT to deliver specified trip reductions. WSDOT sets an upper limit of a $460 annual cost per average daily trip reduced, less than $2.00/day. Although many participants compete for funds at this limit, other projects come in substantially lower (Hillsman, 2009).

One of several effectiveness measures relevant to TDM is congestion reduction. The Seattle I-5 corridor TDM-impact analysis described in the previous subsection estimated that study area peak period ramp volumes would average about 4 percent higher without the existing CTR programs. Traffic flow theory and observation indicate that it is the last few percentage points of traffic growth that can move congestion from slowed traffic to traffic essentially at a standstill, and vehicle trip reduction should have the opposite effect, unless counterbalanced by induced traffic.

Theory and experience were backed up by the analysis, which (using the CORSIM traffic simulation model) determined that spatial congestion in the study area—measured in lane miles of congestion—would increase by 23 percent in the 4-hour AM peak period and 44 percent in the 4-hour PM peak period in the absence of current TDM programs. Similarly, it was determined that temporal congestion expressed as the timespan during which 20 percent or more of the network is congested would increase by 31 percent in the AM and 30 percent in the PM. With results such as these, it is possible to see how Washington State's Commute Trip Reduction Task Force in 2005 estimated that Washington's CTR programs were saving at least $24 million annually in reduced Puget Sound travel delay cost (based on 2003 data). Workers at CTR sites were estimated to be saving $13.7 million in fuel costs. The state's CTR program investment in 2005 was $2.7 million. This leverage was combined with additional investment by local jurisdiction partners and participating employers (Georggi et al., 2007). The employer contribution is understood to be in the $30 to $40 million range (Hillsman, 2009). A full-scale cost-effectiveness evaluation would obviously fully quantify not only these additional cost contributions, but also additional societal and corporate/institutional costs and benefits.

Energy and Environmental Relationships

Because their purpose is to reduce vehicle trips and vehicle miles of travel, TDM strategies are frequently considered as mechanisms to reduce energy use and vehicle emissions. The outcome for both—energy used and pollutants emitted—is dependent not only on the number of vehicle trips and travel miles. It is also dependent on the operating conditions under which the trips and travel occur, as well as the state of engine and fuel technology. From the mid-1970s, as a result of concerns about foreign petroleum dependency and growing problems with air pollution in American cities, legislation has pushed vehicle manufacturers and petroleum companies to improve upon the performance of their products. Beginning with the 1978 model year, foreign and domestic vehicle manufacturers were obliged to meet federal standards and time schedules for corporate average fuel economy (CAFE standards) and rates of emissions (Hillsman, 2009). Hence, the domestic vehicle fleet (light duty much more than heavy duty) has seen fuel economy and emissions performance grow. Perhaps the biggest gains occurred in the 1990s following passage of the Clean Air Act Amendments, and more may now be anticipated in the future.

The purpose of this background is to convey the perspective that energy consumption and vehicle emissions are derived outcomes depending heavily on the state of technology and fuels, which have been evolving rapidly. Therefore, it can be potentially misleading to attempt comparisons of the capabilities and cost-effectiveness of particular TDM strategies in reducing emissions or fuel consumption using past data, given that there are so many context variables that contribute to the outcome.

In spite of the fuel conservation efforts of the 1970s, as the real cost of fuel softened in subsequent years, manufacturers lured consumers back to large, heavy, and high-horsepower vehicles. These included light trucks and SUVs, which faced much less restrictive fuel economy and emissions standards. Partially as a result, but also in response to increased driving overall, transportation energy consumption rose markedly and has returned as a major policy issue. As such, it is a key element of foreign petroleum dependency and global warming concerns.

Also, while vehicles have become less polluting of ozone-contributing gasses (VOC, NOx, and CO), the past focus has not been on greenhouse gas emissions. The greenhouse gas pollutants, primarily CO_2, are directly tied to fossil fuel combustion. Conventional emissions control technology cannot effectively mitigate the greenhouse gas effects of high rates of motor vehicle use. Only fossil fuel consumption reduction—a function of fuel efficiency enhancement and VMT reduction—can lower CO_2 emissions.

There have been many studies where TDM measures have been considered and analyzed for adoption as Transportation Control Measures (TCMs) to mitigate pollution impacts. In a Transportation Research Board study of the benefits of the U.S. government's Congestion Mitigation and Air Quality (CMAQ) program published in *TRB Special Report 264,* a literature review examined scores of Metropolitan Planning Organization (MPO) and academic research studies that attempted to estimate the travel and emissions effects of TCMs. It was found, however, that virtually all of these studies were limited in that they were modeling efforts and not empirical studies. Consequently, only a small number of studies provided the basis for the CMAQ review. The selected studies had the characteristic that their travel impacts were based on empirical observation, though emissions models were necessary to estimate the travel impact effects on emissions.

Perhaps the most substantial resource used by the TRB/CMAQ study was a set of demonstration projects conducted in California under various sponsors in the 1990s. The common denominator of these studies was the way their impacts were determined. Each of the projects had been closely monitored through before-and-after data collection, accompanied by detailed tracking of costs and operating characteristics. The three different programs involved were the Los Angeles County Metropolitan Transportation Authority (MTA) TDM Demonstration program, which funded more than 170 TDM projects to test the costs and effectiveness of eight categories of projects in reducing vehicle trips, VMT, and emissions; California law/program AB2766, which provided $60 million in funding from vehicle registration revenues toward 250 projects aimed at reducing vehicle air pollution; and the San Diego-Coronado Bridge Toll Revenue Program, which used bridge toll revenue to finance projects to increase bridge capacity and reduce congestion and improve air quality (Committee for the Evaluation of the Congestion Mitigation and Air Quality Improvement Program, 2002). A summary covering these three programs has been presented in a 1998 TRB paper (Pansing, Schreffler, and Sillings, 1998). Results of this assessment are shown in Table 19-37.

The table shows the range of impacts on vehicle trips and travel, four key pollutants, and the corresponding cost associated with reducing each. Unfortunately, while overall travel impacts were measured, underlying modal shares were not reported for these projects. Predictably, the range of impacts across all strategy categories—both for travel and emissions—is so broad as to preclude strong conclusions about relative cost-effectiveness, since the impact is substantially controlled by the scale (cost) of the project. Even when normalized in relation to cost, one still observes a considerable range in the cost-based performance for most of the strategies, likely related in part to ambient conditions. The biggest ranges in performance are associated with the alternative-fuel-vehicle measures and the transit improvements, while the core TDM measures (with the exception of telecommunications) seem more stable in their measured performance. Generally what can be observed from these data is the rather favorable performance of the TDM strategies (except telecommunications and to some extent vanpools) in reducing VMT and emissions.

Largely but not entirely similar conclusions were reached in the TRB/CMAQ evaluation itself. Table 19-38 offers a summary of the emissions cost-effectiveness taken from Table E-4 of the CMAQ study. The median values shown are also derived from a fairly wide range of impacts found in the representative projects (Committee for the Evaluation of the Congestion Mitigation and Air Quality Improvement Program, 2002).

Table 19-37 Comparative Travel, Emissions, and Cost-Effectiveness of Transportation Control Measures—Three California Programs

	Travel Impacts		Emissions Impacts (Lbs.)				Cost per Travel Impact		Cost per Emissions Reduction (per Lb.)
Project Category	**VTR**	**VMTR**	**HC/ROG**	**NOx**	**CO**	**PM-10**	**Cost per VTR**	**Cost per VMTR**	
Alternative Fuel Vehicles	441–594,080	13,716–4,752,641	23–12,806	23–9,269	192–121,067	72–26,649	$0.22–$18.70	$0.03–$1.23	$3.06–$1,351.00
TDM									
Bicycle Facilities	3,480–33,840	11,760–486,174	46–864	38–845	668–7,503	6–2,546	$0.43–$4.04	$0.02–$0.71	$0.83–$26.00
Financial Incentives	40,858–141,600	1,292,760–6,056,880	2,130–8,865	2,301–10,089	18,979–77,881	668–2,804	($0.44)–$7.04	($0.01)–$0.37	($0.63)–$19.98
Organizational TDM	53,760–63,360	950,400–966,800	1,632–1,678	1,744–1,760	16,435–17,506	440–448	$2.65–$3.48	$0.18–$0.19	$7.85–$9.23
Telecommunications	0–95,520	40,800–5,966,880	80–9,120	80–10,553	895–76,921	19–2990	$1.13–$3,236.00	$0–$17.00	($4.56)–$661.00
Vanpools	14,227–143,500	737,528–6,880,000	735–9,420	713–10,168	6,420–79,031	237–32,782	$1.33–$20.49	$0.03–$0.48	$1.45–$46.67
Transit Improvements									
Line Haul	1,344–594,080	21,360–4,752,641	137–12,806	(55)–9,269	975–121,067	5–26,649	$0.22–$35.00	$0.03–$2.20	$3.06–$1,117.00
Shuttle	1,984–35,713	9,950–835,380	187–1,019	6–1,100	2,376–10,056	14–286	$3.68–$75.60	$0.05–$27.70	$6.52–$610.00

Source: Pansing, Schreffler, and Sillings (1998).

Table 19-38 Emissions Reduction Cost-Effectiveness of TDM and Other CMAQ-Funded Strategies

CMAQ Strategy	Median Cost per Ton	CMAQ Strategy	Median Cost per Ton
Inspection and maintenance	$4,500	Modal subsidies and vouchers	$125,400
Regional rideshare programs	$18,500	Park-and-ride (transit and rideshare)	$127,500
Charges and fees	$27,900	Bicycle/pedestrian programs	$206,600
Vanpool programs	$30,400	New transit capital systems/vehicles	$208,000
Miscellaneous TDM	$34,100	Shuttles, feeder, paratransit	$214,700
Traffic signalization	$35,200	Freeway/incident management	$240,900
Alternative fuel vehicles	$53,000	HOV facilities	$316,200
Employer trip reduction	$56,900	Alternative fuel buses	$355,700
Conventional fuel bus replacement	$63,200	Telework	$743,200
Conventional transit service upgrades	$64,600		

Note: Effectiveness measure is median cost per ton of emissions reduced (VOCs + NOx).

Source: Committee for the Evaluation of the Congestion Mitigation and Air Quality Improvement Program (2002).

Two important conclusions were reached by the TRB/CMAQ study:

- The success of any strategy depended greatly on its being applied in an appropriate context.
- Several of the strategy categories that had favorable cost-effectiveness in reducing emissions were of the TDM genre.

While inspection and maintenance ranked as the most cost-effective of all strategies, well above average cost-per-ton performance was found in the TDM categories of regional ridesharing programs, charges and fees, vanpool programs, miscellaneous TDM, and employer trip reduction. Conversely, among the least cost-effective TDM strategies were telework programs, transit shuttles or feeder lines, and bicycle/pedestrian facilities and programs. Also less cost-effective than the top 10 strategies for reducing emissions were such widely popular Transportation System Management (TSM) measures as park-and-ride lots, freeway/incident management programs, and HOV facilities (Committee for the Evaluation of the Congestion Mitigation and Air Quality Improvement Program, 2002).[19]

The two areas where conclusions differed markedly between the California-based studies and the TRB/CMAQ study were with respect to vanpools and bicycle facilities. Note that while vanpooling exhibits a tendency toward disappointing cost-effectiveness in the summary of California studies (see Table 19-37), the cost spread is wide, and it places a respectable fourth out of 19 for

[19] A significant limitation affecting single-objective/single-function cost-effectiveness (or cost-benefit) analyses such as these is that other benefits to individuals or society are not considered. This issue is expanded upon with respect to non-motorized transport (NMT) facilities in Chapter 16, "Pedestrian and Bicycle Facilities." See "Economic and Equity Impacts" in that chapter's "Related Information and Impacts" section.

cost-effectiveness in the TRB/CMAQ study. Conversely, bicycle facilities appear relatively cost-effective for emissions reductions in the California studies summary, while appearing 2/3 of the way down the TRB/CMAQ cost-effectiveness ranking.

Finally, referring back again to the previously described Seattle I-5 corridor TDM-impact analysis, the CORSIM traffic simulation of conditions in the 8.6-mile study corridor produced emissions impacts with and without the 2003 TDM programs at the 189 CTR-participant employers. It was estimated that, absent the CTR-based TDM programs, AM and PM peak-period HC emissions would increase by a total of 38.1 kilograms, representing a 10.3 percent increase in the AM period and a 13.1 percent increase in the PM period. Estimated peak-period CO emissions increases would total 2,654.3 kilograms, a 9.6 percent increase in the AM and a 12.7 percent increase in the PM. Similarly, NOx emissions would increase by a peak-periods total of 122.2 kilograms, an 8.9 percent increase in the AM period and a 10.9 percent increase in the PM period (Georggi et al., 2007).

ADDITIONAL RESOURCES

Many of the other chapters of this *TCRP Report 95,* "Traveler Response to Transportation System Changes" Handbook constitute additional resources for TDM. More specifics are provided in the introduction to this chapter's "Overview and Summary" section. Additional resources external to *TCRP Report 95* include the following materials.

FHWA TDM Report, Practitioner Manuals, TDM Model, and Website Resources

Perhaps the most comprehensive set of research and guidance materials on employee-focused TDM is still the report series titled *Implementing Effective Travel Demand Management Measures,* prepared by Comsis and the Institute of Transportation Engineers (ITE) in 1993 for the Federal Highway Administration, with support from the Federal Transit Administration. The set of materials in this series includes:

- A main report with the following three sections (Comsis and ITE, 1993):

  Part I—A basic "Introduction to Travel Demand Management," including an overview of strategies, terminology, application environments, and expectations for impact.

  Part II—An "Inventory and Review of TDM Measures," with detailed information on 11 categories of strategies, including improved alternatives (transit, carpool, vanpool, and bike/pedestrian improvements); incentives and disincentives (complementary support measures, HOV priority treatments, economic incentives, parking supply and pricing, and tolls and congestion pricing); and alternative work arrangements (variable work hours, compressed work weeks, and telecommuting). Included for each strategy is a description of its various forms, when and where it is most appropriately used, how it achieves its impact, other strategies with which it is or is not complementary, examples in application, ranges of potential impact, implementation issues, and additional references.

  Part III—A "Synthesis of Findings" that first introduces empirical findings from a sample of TDM programs, analyzing and discussing them in a manner to help reveal those features that are most critical to success. An analytic tool, the TDM Evaluation Model, is then presented as a means of estimating combined effects of TDM strategy packages applied in different travel settings. The model is used to create tables and graphs that indicate ranges of impacts of each strategy across different levels and settings. Cost-effectiveness is then explored, and guidance is provided to assist in design and implementation of real-world TDM programs.

- A set of three Practitioner Guidance Manuals, also prepared for FHWA but published and distributed by the Institute of Transportation Engineers (ITE):

  Implementing Effective Employer-Based Travel Demand Management Programs, A Guidance Manual. For employers or professionals designing employer TDM programs, this manual provides an introduction to TDM, objectives, review of strategies, and recommended steps to take in designing and implementing a program. There is a worksheet section where the user is led through a program design, in which tables and charts are provided to ascertain the impact of the particular set of strategies selected (ITE, 1993).

  Areawide Travel Demand Management Programs, A Guidance Manual. This resource provides similar guidance in understanding and designing alternative TDM programs, but from the perspective of either a public agency or an area-wide organization such as a TMA or transportation district. This manual incorporates both employer-side measures and area-wide measures such as those that a public agency might initiate (ITE, 1992a).

  Marketing Research for Transportation Demand Management Programs, A Guidance Manual. Provides special guidance on how to obtain the appropriate data and conduct the proper analyses to better ensure that the right strategies are chosen in relation to characteristics of the particular market. Covered are market research methods, research questions and information needs, information gathering techniques, data analysis methods, and special calculation forms and a look-up table as aids for applying the marketing research results (ITE, 1992b).

- An FHWA public-use version, with accompanying User's Guide, of the Comsis TDM Evaluation Model.

  FHWA offers contemporary TDM information through its "Travel Demand Management" webpages at http://ops.fhwa.dot.gov/tdm/index.htm and the "Travel Demand Management Toolbox" found therein. The report, *Mitigating Traffic Congestion: The Role of Demand-Side Strategies,* linked through the "Publications and Reference Materials" section of the toolbox, places TDM in a broader context of demand-side strategies. This report provides an overview discussion of each type of demand-side strategy along with 26 case studies (Association for Commuter Transportation et al., 2004).

Center for Urban Transportation Research Resources

The National Center for Transit Research at the Center for Urban Transportation Research (CUTR) at the University of South Florida maintains a highly active program of research and analysis dedicated to Transportation Demand Management. The following is a list of reports, references, or services of interest.

Economics of Travel Demand Management: Comparative Cost Effectiveness and Public Investment. This 2007 project developed a methodology that combines academic and practitioner experiences within a theoretical framework that aims to capture consumers' price responsiveness to diverse transportation options by embracing the most relevant tradeoffs faced under income, modal price and availability constraints. This work may be accessed at http://www.nctr.usf.edu/pdf/77704.pdf.

Development of the theoretical model led to the design and implementation of Trip Reduction Impacts for Mobility Management Strategies (TRIMMS), a practitioner-oriented, sketch-planning tool. The spreadsheet, which includes elements for estimating the effects of the "soft" marketing and support strategies, is available for download at http://www.nctr.usf.edu/spreadsheet/TRIMMS.zip.

Impact of Employer-based Programs on Transit System Ridership and Transportation System Performance. This is the full 2007 report on the Seattle I-5 TDM impact analysis covered in the "Related Information and Impacts" section under "Site- Versus System-Level Impacts"—"End Results of Dissipation." It includes description of the analysis methodology and can be accessed at http://www.nctr.usf.edu/pdf/77605.pdf.

National Smart Transportation Archive Researcher. The National Smart Transportation Archive Researcher (NSTAR) was developed to make available an online, updatable, easily searchable database of case studies documenting effective use of TDM strategies to reduce VMT and SOV mode share. The database is intended for use by transportation professionals and worksite employee transportation coordinators to develop and improve the effectiveness of their own programs. The database is located on the Help Desk of the National TDM and Telework Clearinghouse at http://www.nctr.usf.edu/clearinghouse.

The accompanying *Best Practices Guide* features 12 in-depth case studies of some of the more effective worksite trip reduction programs. These particular worksites are located in Washington State and reflect a mandatory regulatory environment requiring employers to participate and produce results. The case studies were developed from data of the Washington State Department of Transportation's Commute Trip Reduction Program along with interviews with worksite employee transportation coordinators. The *Best Practices Guide* is available at http://www.cutr.usf.edu/tdm/pdf/NSTAR.pdf. Over 100 employer case studies may be viewed at http://www.nctr.usf.edu/helpdesk/casestudies.htm.

State and Regional Program Reports

A series of evaluation reports developed for the Los Angeles County MTA TDM Demonstration Program provide not only information on the range of VMT, air quality, and cost impacts of a wide range of TDM strategies, but also serve as a practical guide in methods of empirical evaluation. While the vast majority of TDM or TCM measures are designed and implemented with little or no data gathered on their net effects, this study is exemplary in the careful application of before-and-after evaluation data collection methods, by far the most reliable way to assess travel and other impacts when many internal and external variables are at play. See in particular the *MTA Transportation Demand Management Evaluation* Final Report (Comsis and Pansing, 1997) and the *MTA TDM Demonstration Program Third-Party Evaluation* Final Report (Comsis et al., 1996)

The Washington State Legislature created a trip reduction performance program in 2003 to encourage entrepreneurs, private companies, transit systems, cities, non-profit organizations, developers, and property managers to provide services to employees that result in fewer vehicle trips arriving at worksites. The final report for 2003–2005 contains case studies with before-and-after data. It is found at http://www.wsdot.wa.gov/NR/rdonlyres/FF9220C9-EC49-46B7-A84D-B5103C63F0CA/0/20032005_CTR_ProgramReport.pdf.

The Washington State DOT Commute Trip Reduction (CTR) Program 2005 annual report notes that employee drive-alone rates, vehicle trips, and VMT to CTR worksites have decreased significantly. However, it also notes that progress toward the program's statutory goals has been variable.

See http://www.wsdot.wa.gov/NR/rdonlyres/172087A9-85D1-416B-86C4-33281C7BDE68/0/CTR_Report_05.pdf. A related web document highlights the extent that public dollars are leveraged with private (employer) dollars invested in CTR: http://www.wsdot.wa.gov/TDM/CTR/funding.htm#impacts.

Other Information Sources

TCRP Report 87, "Strategies for Increasing the Effectiveness of Commuter Benefits Programs" (2003) may be accessed via http://144.171.11.107/Publications/Blurbs/Strategies_for_Increasing_the_Effectiveness_of_Com_152144.aspx. Marketing tactics and messages are suggested in the course of addressing means to promote effective programs. Appendix D, Table D-6, has a list of approximately 40 employers who offer commuter tax benefits to employees, along with their participation rates.

The Victoria Transport Policy Institute (VTPI) *Online TDM Encyclopedia,* developed and actively maintained by the VTPI, is a comprehensive resource on a wide range of transportation management strategies (Victoria Transport Policy Institute, 2009). The Encyclopedia is a truly "online" resource, accessible at http://www.vtpi.org/tdm/index.php, and offers a high degree of flexibility in searching for and extracting information on TDM. The Encyclopedia describes a large number of TDM applications and contains information on TDM planning, evaluation, and implementation. Hyperlinks provide access to more detailed information, including case studies and reference documents. The *Online TDM Encyclopedia* has an international perspective, with ideas and examples from across the world. VTPI, the creator and supporter of the Encyclopedia, is an independent research and consulting organization located in Victoria, British Columbia.

Canadian government resources include the Transportation Demand Management Database, found at http://www.tc.gc.ca/programs/environment/UTSP/tdm.htm. Included are profiles and results for 92 projects worldwide, focused on sustainable development, energy efficiency, accessibility, and increased productivity.

A good summary of TDM experience in the Netherlands and in the United Kingdom is provided by the British study *Smarter Choices—Changing the Way We Travel,* prepared for the Department for Transport (DfT) (Cairns et al., 2002).

Analytic Tools

One of the earliest tools still in use is the TDM Evaluation Model. It was developed by Comsis Corporation in the early 1990s from a combination of empirical TDM research studies and traditional transportation planning logit mode split models. The original purpose was to supplement the conventional "four-step" metropolitan travel forecasting process when performing corridor, subarea, or even regional transportation impact studies involving TDM alternatives. Voluntary and mandatory employer participation rates are taken into account.

The TDM model is generally applied to regional forecast trip tables (base year, present year, or future), and is used to estimate the impact on mode split, vehicle trip rate, and VMT for each origin-destination pairing. The revised trip tables may then be returned to the four-step (or other) travel demand model for traffic assignment. In this manner it is possible to interpret the effects of employer TDM programs on actual facility volumes and levels of service. Model outputs may then be used for air quality analysis. The model is also a reasonably convenient way of investigating the traffic impact of new development projects and the benefits of applying development-level TDM mitigation. The Federal Highway Administration's public version of the TDM model is available via the FHWA website at http://www.fhwa.dot.gov/environment/cmaqeat/descriptions_tdm_evaluation_model.htm.

Subsequent TDM modeling tools have focused more narrowly on the design and impact of individual employer/institutional programs. In other words, the subject is an individual site, and not a population of employers such as might be targeted under an area-wide program initiative or ordinance. Examples of such tools include the Travel Demand Management Program software developed for the South Coast Air Quality Management District in Los Angeles by the California Air Resources Board (Comsis, 1993b). The research behind the development of this model was presented earlier in the "Related Information and Impacts" section under "Modeling Studies," along with the more recent Worksite Trip Reduction Model developed by CUTR.[20]

Another fairly recent model, again with a single-employer focus, is the U.S. Environmental Protection Agency's COMMUTER Model. It was developed under contract by Sierra Research, drawing heavily from the original TDM Evaluation Model. A major literature review was conducted to identify new sources of impact information for each of the strategies featured in the model (Sierra Research, 1999). There has been a model coefficient update as of 2002 (U.S. Environmental Protection Agency, 2005), supporting a version 2.0 of the model. Perhaps the biggest change over the TDM Evaluation Model, other than the convenience of a modern, menu-aided user interface, is the ability to calculate emissions. The model was created to support the introduction of voluntary emissions reduction programs for metropolitan nonattainment areas seeking credit for air quality conformity demonstrations. The model and version 2.0 manuals can be accessed and downloaded from the EPA site at http://www.epa.gov/otaq/stateresources/tools.htm.

CASE STUDIES

"Transportation Days" Marketing and Outreach Programs—Cross Westchester Expressway Corridor

Situation. In Westchester County, New York, the Cross Westchester Expressway linking Tarrytown, White Plains, and Port Chester with the New York State and New England Thruways attracted major development during the 1970s and ′80s. By 1980, the corridor had 100,000 jobs, and during the 1980s more than 20,000 new jobs were added. By 1985, congestion during peak travel periods was becoming routine, and long queues were occurring both morning and evening on the Tappan Zee Bridge. A major factor in bridge congestion was the crossing of Rockland County residents over the Hudson River to reach the jobs in Westchester County. Studies supported by Westchester County, New York State DOT, New York Metropolitan Transportation Council (NYMTC), and private groups identified a need for adding transportation capacity to the Tappan Zee Bridge and the Cross Westchester Expressway. However, it was also recognized that these improvements would be costly and take many years to accomplish. In the interim, attention was turned to making more

[20] As noted in the "Related Information and Impacts" section under "Modeling Studies," CUTR issued an update to the Worksite Trip Reduction model during the timeframe of the Chapter 19 review and publication process. The update is known as TRIMMS© Version 2.0 and provides parameter, user-interface, and benefit-analysis enhancements and revisions (Concas and Winters, 2009).

efficient use of existing facilities by encouraging commuters to switch from single occupant vehicle (SOV) commuting to transit and ridesharing.

Actions. In 1989, the New York State Energy Office awarded a grant to the Westchester County Department of Transportation to "develop, market, implement, operate, support and monitor Transportation Management Programs" for the purpose of saving energy, reducing congestion and air pollution, and providing transportation alternatives. A specific goal of removing 1,100 SOVs from daily commuting was established. The program developed to meet these objectives included bringing employers, developers, building managers, and local and state officials together in an ad hoc advisory group to support program activities; conducting a survey of workers to identify commuting patterns and needs; targeted transit service improvements; preparing a marketing and information package on commuting options; presenting the marketing and information materials in "Transportation Days" held at work places through the corridor; and evaluating the results of the program activities.

The employee survey was distributed to over 20,000 workers at 130 employers in the corridor in September 1990. From approximately 6,500 responses, results of the survey were used to fashion a set of transit service modifications for implementation in the fall of 1991. Concurrently, a marketing and information program was developed, including a slide show with presentation script and a Commuter Information Package. The slide show was later recorded on video for use at Employee Transportation Days, which were conducted throughout 1992 at the work sites of 79 employers in the corridor, representing almost 12,000 employees. Almost 3,000 information packages were distributed through these activities, with an additional 2,500 packages distributed through other agencies and meetings.

Analysis. In February 1993, a sample of workers who responded to the 1990 survey were recontacted to obtain information on their exposure to the marketing program and any changes in commuting patterns. This was made possible by having obtained the employee's work phone number in the 1990 survey. Only employees whose employer participated in Employee Transportation Days or had received the Commuter Information Packages were contacted. Of roughly 1,300 names and phone numbers from the original survey, contact was made with 596 phone numbers. Because of employee turnover during the 2-year period since the initial survey, the individual answering the phone was often not the original respondent. This difference was noted and the survey was administered anyway, primarily attempting to determine whether the employee had changed modes and the factors behind that decision.

Results. Of the 596 persons participating in the follow-up survey, 356, or about 60 percent, were the same individual surveyed in the original survey. Thus 240, or 40 percent, were different and considered "new" employees since the 1990 survey. Of the 356 repeat respondents, 71 (18 percent) indicated that they had attended a Transportation Day event, compared to 31 (13 percent) of the 240 "new" respondents. Overall, 190 of the 596 total respondents changed commute mode between 1990 and 1993. Nevertheless, overall, the percentage of commuters driving alone remained at virtually the same level—68.6 percent before and 69.3 percent after. In terms of vehicle trip reduction (VTR), vehicle trips per 100 workers increased from 77.4 to 79.3 during the period, indicating that vehicle trips actually *increased* by 2.5 percent.

The subgroup of respondents classified as "new" employees (not in the 1990 survey) appear to have shown greater tendency to shift modes than those who were surveyed previously. Only 83 of the 356 "repeat" respondents, or 23.3 percent, indicated a change in mode in the second survey, compared to 107 of 240, or 44.6 percent, of the "new" respondents. Whereas that higher rate of mode shift might not be universally positive—commuters could have changed to or from driving alone—

the "new" group also logged a better trip reduction than the "repeat" group. Drive-alone rates for the "repeat" group increased from 66.9 percent to 69.4 percent during the program, representing an *increase* in vehicle trips of 5.1 percent (77.7 to 81.7). In the "new" group SOV use declined from 71.3 percent to 69.2 percent. Vehicle trips were reduced by 0.6 percent (down from 78.3 to 77.8 per 100). A possible explanation is that the new employees were more likely to be considering alternatives during their period of transition.

Looking at the entire sample of 596 respondents, of the 409 (69 percent) who drove alone prior to the program, 332 (81 percent) continued to drive alone after program efforts, while four (1 percent) chose to walk, 45 (11 percent) chose to rideshare, 24 (6 percent) shifted to transit, and the remaining four (1 percent) chose "other." Of those 98 (16 percent) who originally were in ridesharing, only 37 (38 percent) continued to rideshare, 49 (50 percent) switched to driving alone, six (6 percent) switched to transit, and the remaining six (6 percent) walked or traveled by "other" means. Finally, of those 74 (12 percent) who previously commuted by transit, 39 (53 percent) continued to take transit, while 24 (32 percent) switched to SOV, six (8 percent) switched to ridesharing, and the remaining five (7 percent) walked or traveled by other means. So, in effect, rideshare commuters proved to be the least likely of all modal groups (not counting the 15 respondents originally reporting walk or other modes) to stay with their original mode (38 percent), while those who drove alone were the most likely to retain their original mode (81 percent)—a substantial margin of difference.

Closest to the primary focus of the evaluation was the extent to which the marketing and information program, and particularly the conduct of Transportation Days, was influential in triggering a mode shift. As shown in Table 19-39, a higher percentage of workers who attended a Transportation Day switched from driving alone (the share dropped from 68.6 percent to 63.7 percent) than did the workers who did not attend, where drive-alone rate actually increased from 68.9 percent to 70.8 percent. In general the group that attended also showed greater tendency to shift to vehicle-trip-saving modes, including transit and walking, while those who did not attend showed only a slight shift to transit and to "other." ("Other" has been assumed to be driver-serve-passenger or taxi.) The shifts of the group that attended resulted in a vehicle trip reduction of 7.5 percent, while the shifts of those who did not attend resulted in a vehicle trip *increase* of 4.2 percent. The question to be asked is whether the Transportation Day strategy was responsible for the switch, or whether the persons interested enough to attend the event were more highly disposed to considering and seeking an alternative mode.

Table 19-39 Employee Mode Split Before and After "Transportation Days" Marketing and Outreach Program

	Attended Transportation Day		Did Not Attend Transportation Day	
Mode	**1990**	**1993**	**1990**	**1993**
Walk	0.0%	2.0%	1.5%	1.1%
Drive Alone	68.6%	63.7%	68.9%	70.8%
Rideshare	13.7%	11.8%	16.9%	15.6%
Transit	16.6%	21.6%	11.5%	10.0%
Other	1.0%	1.0%	1.5%	2.5%
Vehicle Trips per 100	76.1	70.4	78.7	82.0

When asked to identify reasons for changing commute mode, no respondent cited attendance at a Transportation Day at the workplace as a primary reason for doing so. Rather, 10 percent said it was because their work schedule had changed, 12 percent attributed it to a change in residence, and another 12 percent linked it to buying or selling a car. Of those who specifically changed mode from driving alone, the top reasons were that a carpool/vanpool option opened (14 percent), driving alone was too expensive or hard on the vehicle (8 percent), the car became unavailable as an option due to mechanical condition or competing uses (5 percent), or the carpool/vanpool offered more convenience (5 percent). Meanwhile, those who shifted mode *to* driving alone cited loss of a carpool/vanpool member (11 percent); discovery that taking the bus was inconvenient/uncomfortable (9 percent); need for use of the car en route to, from, or while at work (5 percent); or that the company moved (2.4 percent), ridesharing was stressful (2.4 percent), or parking became available (1.6 percent).

In a very generic sense, however, being exposed to the marketing and informational materials—either at a Transportation Day or through receipt of the Commuter Information Package—influenced a somewhat higher percentage of commuters to change modes. Of the 292 survey respondents who saw the information, 100 (54 percent) changed modes, versus only 86 of 295 (46 percent) who did not see the information. Nevertheless, it appears that the only conclusion that can be reached from these findings is that some connection exists between exposure to the marketing materials and a shift in mode. Whether or not the persons who sought this information were also those who were actively looking for an alternative cannot be satisfactorily determined from the data.

More . . . Somewhat complicating results for this evaluation is the fact that an economic recession took place in 1991–92, which had a major effect on rates of hiring and termination. The downturn in activity was felt to diminish the perception and concern about traffic. However, at the same time the passage of the 1990 Clean Air Act Amendments brought new interest in employer trip reduction programs, the New York metropolitan area having received a "severe" nonattainment rating with respect to ozone. It is unclear to what extent these two potentially counterbalancing events impacted the study results or interacted with each other.

Source: SG Associates, Inc., and Howard/Stein-Hudson Associates, Inc., "Cross Westchester Expressway Corridor Transportation Systems Management Program." Final Report. Westchester County Department of Transportation (March, 1993) • Spielberg, F., Bloch, A., Bogacz, G., and Johnson, V., *Evidence of the Effectiveness of Employer Sponsored Transportation Days.* Unpublished [1993].

University of Washington's U-PASS Program—Seattle, Washington

Situation. The University of Washington's (UW) Seattle campus occupies 643 acres in the University District, about 3 miles north of downtown Seattle, across Lake Union and Portage Bay. As of 2005, student enrollment was about 39,000 and faculty and staff was about 22,000, compared to about 27,900 and 17,000 in 1991. The size of this operation, the demand it was placing on the local transportation system, the desire to grow, and the trends in demand for campus parking, led university officials to develop a Transportation Management Plan (TMP) in 1983. The purpose was to expand travel options for students, faculty, and staff and thus shift them away from single-occupant vehicle travel. Specific goals included maintaining 1983 traffic volumes to and from campus during peak periods and limiting on-campus parking supply to 12,300 spaces, while ensuring that spillover into the surrounding neighborhoods would not result. Subsequently, in the course of developing of a 1989 General Physical Development Plan for the campus, university officials realized that growth plans would result in a significant increase in vehicle trips, along with a loss of about 1,700 surface parking spaces. A task force formed to develop a new TMP to address this concern seized on the importance of combining transportation incentives (mostly in the from of cheap and available transit) with complementary disincentives (higher parking fees) in the new plan.

Actions. The core strategy of the new TMP was the U-PASS, a universal pass providing cardholders with a range of transportation options and incentives. U-PASS began as a 3-year pilot program in 1991, and based on its proven success, has continued to this day. In 2005 the U-PASS could be purchased at a price of $41 per quarter by students and $57 per quarter by faculty and staff. The pass provides holders unlimited rides on any of the regional or local transit services, reduced carpool and free vanpool parking, vanpool subsidies (up to $40 monthly), discounted "occasional" parking permits, ridematching services, local merchant discounts (including bicycle equipment and services), emergency ride home (for employees), subsidized use of FlexCar carsharing services, and access to Night Ride evening neighborhood shuttle service. UW uses more than 90 percent of its annual U-PASS budget ($13 million in 2005) for the purchase of service through contracts with local public transportation providers. The large number of riders and consistency of revenue has led transit providers to greatly increase the amount and quality of transit service to the campus.

Managing parking is a key element of the TMP, and the pricing of parking is a major component of the U-PASS program. The introduction of U-PASS was accompanied by a 50 percent increase in the cost of parking. The University has maintained a policy of controlling the rise in U-PASS fees and keeping them significantly lower than the cost of parking. In 2005, the cost of a U-PASS for employees is about one-fourth the cost of a parking permit. The cost of quarterly parking permits has increased from $108 in 1991 to $233 in 2005 (116 percent), while gate-issued daily parking has increased from $4 to $10 (150 percent), and parking at the Montlake lot has gone up from $1.25 to $4 per day for cash payments (220 percent) and $2.62 for those who choose to debit the charge to their university Husky Card™. Meanwhile, the cost of a student U-PASS has only increased by 105 percent, from $20 to $41 per quarter, and for employees by 111 percent, from $27 to $57 per quarter.

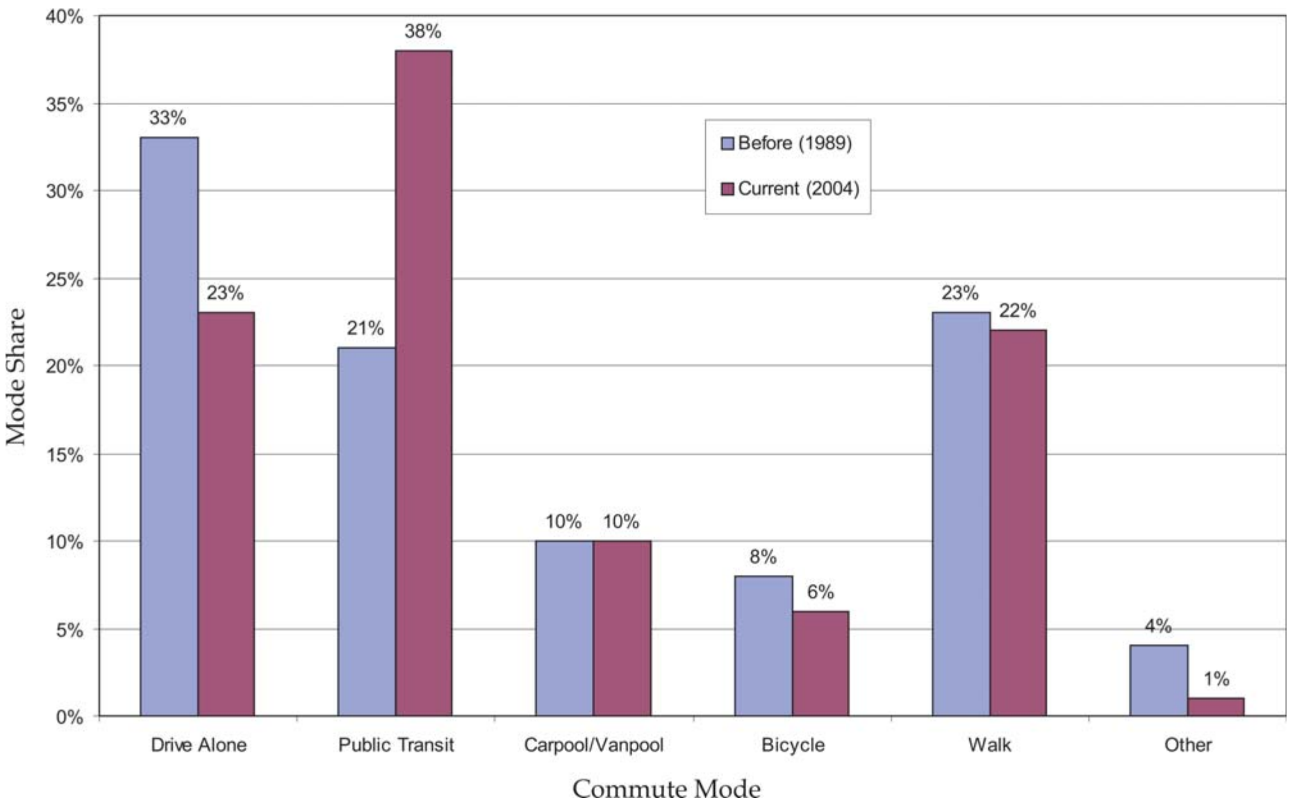
Eligibility for U-PASS includes students registered in state-funded courses, or those taking degree-credit courses on the Seattle campus through UW Extension. Faculty and staff employed in permanent positions and working at least half-time, temporary and hourly employees working at least 3 days per week, Visiting Scholars, and retirees employed on campus 40-percent-time or at least 3 days per week, are also eligible for U-PASS. During 2005, the average number of U-PASSes in use was 44,156, an increase of 21 percent from the time the program was introduced in 1991. Eighty-six percent of students and 54 percent of employees participated in the program in 2005.

Analysis. Travel patterns of faculty, staff, and students are measured through a biennial survey, conducted in the fall of even-numbered years. The results are compiled into biennial U-PASS reports and related evaluations for use in university administration and by other interested parties.

Results. Despite a 22 percent growth in the employee and student population, university-related peak hour traffic remains below 1990 levels, and more than three-quarters of the campus population travels to campus in a mode other than driving alone. Commute mode shifts, especially the shift from driving alone to public transit, are given primary credit for the traffic mitigation. As seen in Figure 19-2, prior to the U-PASS program (survey in 1989), 33 percent reached the campus by driving alone, 21 percent by public transit, 23 percent by walking, 10 percent by carpool/vanpool, 8 percent by bicycle, and 4 percent by other means. By 2004, the drive-alone rate had dropped to 23 percent, while public transit increased to 38 percent. Carpool/vanpool remained the same at

10 percent, while bicycle (6 percent), walk (22 percent), and "other" (1 percent) dropped slightly. Assuming that "other" is either driver-serve-passenger or taxi, a vehicle trip rate in 2004 of 29 per 100 may be computed and compared with a rate of 42 in 1989. This gives a VTR of 31 percent.[21]

Figure 19-2 Commuting mode choices at the University of Washington before and after U-PASS program implementation



The effect of the parking pricing strategy, along with the other U-PASS elements, has meant a 41 percent reduction in the number of SOV parking permits since program inception. The number of parking spaces used has declined as faculty, staff, and students have shifted away from driving alone. Despite the university's major growth, the total number of parking spaces has held about the same at roughly 11,500, while the average utilization rate has gone from 87 percent in 1990 to 72 percent in 2005.

More . . . Funding for U-PASS in 2005 totaled $12,955,500, of which 49 percent was derived from user fees, 41 percent from parking fees, 3 percent from parking fine revenue, and 7 percent from

[21] This computation conservatively uses an arbitrary 2.0 average carpool/vanpool occupancy for both 2004 and 1989. A less conservative assumption of 2.5 average carpool/vanpool occupancy in both years would give 2004 and 1989 vehicle trip rates of 28 and 41, respectively, and a VTR of 32 percent. In either case, the reduction is roughly one-half the 62 percent trip rate differential calculated in TCRP Project B-4, based on comparison of University travel data to the surrounding area's work commute mode split as reflected in the 1990 CTPP. The 62 percent is what has been used, for consistency, in the various analyses involving the 82-program sample. However, the newer 31 or 32 percent VTR estimate, made with benefit of before-and-after survey data, is clearly the more applicable/reliable.

other university sources. The distribution of program expenditures, also totaling $12.95 million, was principally for transit service contracts (92 percent), accompanied by administration and monitoring (3 percent), marketing and public relations (2 percent), the Night Ride Shuttle (2 percent), ridesharing/ridematch elements (1 percent), and bike and pedestrian improvements (1 percent).

The success of the U-PASS program, and the idea of putting a transit pass into virtually everyone's hands at a greatly reduced price, convinced Metro to extend the idea to employers. This widespread distribution encourages the occasional as well as the regular transit rider. As of the early 2000s, Metro's FLEXPASS program served 130 employers and 118,000 commuters, of which some 44,000 were U-PASS customers. FLEXPASS is believed to have been the first employer-based program of its kind in the nation.

Sources: University of Washington, "2005 U-PASS Annual Report." Transportation Office, Seattle, WA. http://www.washington.edu/upass/news_and_reports/upass_reports/annualreport2005. • Association for Commuter Transportation, Urbantrans Consultants, PB Parsons Brinckerhoff, and ESTC, "Mitigating Traffic Congestion: The Role of Demand-Side Strategies." In partnership with the Federal Highway Administration, U.S. Department of Transportation (2004). • Vehicle trip rate and VTR computations by the Handbook authors.

Staggered Work Hours in Manhattan—New York, New York

Situation. This case study is adapted from the Second Edition "Traveler Response to Transportation System Changes" Handbook because of its particular relevance to addressing transit usage peaks and associated crowding such as were occurring in mid-2008 in response to $4.00/gallon gasoline prices. On April 1, 1970, the Port Authority of New York and New Jersey (PATH: Trans-Hudson Transit), in cooperation with the Downtown-Lower Manhattan Association, initiated a staggered work hours program. The Lower Manhattan area had a worker population of 480,000, about 85 percent of whom used rail transportation for their work trip. A survey of 113 firms with 136,000 employees total indicated that 66 percent began their work day at 9:00 AM and that 64 percent ended it at 5:00 PM.

Actions. The program at first involved about 50,000 employees of 45 concerns. Some 46,000 had their beginning time shifted from 9:00 to 8:30 AM, and 4,000 to 9:30 AM. Within 2 years 250 offices with over 100,000 employees total were participating, and a similar program was being developed for Midtown Manhattan. Schedule shifts of at least 30 minutes were recommended to compel a definite change in commuting habits.

Analysis. Before and after counts were taken in February 1970 and 1972 at three of the area's most heavily used subway stations. Vehicular volumes were also monitored at the Brooklyn Battery Tunnel and the Battery Parking Garage. The employees of 27 firms were surveyed to assess reaction.

Results. The counts showed a 26 percent decline in station usage (17,658 to 13,074) during the peak 9:00–9:15 AM period, and a 24 percent passenger volume increase (12,024 to 14,864) between 8:30 and 8:45 AM. At the PATH World Trade Center Terminal, passenger counts fell 18 percent (7,500 to 6,224) between 5:00 and 5:15 PM, and rose more than 50 percent (3,100 to 4,750) between 4:30 and 4:45 PM. In contrast, the monitoring of vehicular volumes showed little or no significant change attributable to the staggered hours.

About 85 percent of the participating employees sampled in the employee survey favored staggered hours over the previous arrangement. Some 45 percent reported they were experiencing less congestion (50 percent reported no change), and 50 percent were more satisfied with their work trips under the staggered hours program (9.8 percent were less satisfied). Of the supervisors sampled, 24.6 percent reported improved employee punctuality. Only 11.6 percent reported increased tardiness. About 15 percent cited some operational communications problems, but none indicated any actual drop in efficiency.

Reasons for the improved employee punctuality were examined with a study of the distribution and length of all rail rapid transit and commuter rail AM peak-period delays recorded on 18 randomly selected days in 1970. The study indicated that a rapid transit commuter with a 9:00 AM reporting time at work, compared to a commuter with an 8:30 AM reporting time, had a 25 percent greater likelihood of encountering a delay, and that each delay averaged 40 percent longer in duration. Similarly, a commuter rail user starting work at 9:00 AM had a delay likelihood 67 percent greater and an average delay duration 50 percent longer. This equates to a 1 hour morning trip time reduction each month for rapid transit users on an 8:30 AM schedule, and a larger savings for commuter rail users. Interestingly, rapid transit service between 8:10 and 8:30 AM (2,369 trains scheduled) was found to be nearly equal to the service offered between 8:40 and 9:00 AM (2,427 trains scheduled), and train annulments (cancelled or out-of-service trains, which figure more heavily in passenger overcrowding than delay) were 17 percent more frequent for the 9:00 AM commuter than for the 8:30 AM commuter.

More . . . An unknown in considering programs such as this is the extent to which gradual adoption of flexible work hours in recent years may have reduced the remaining potential for alternative work arrangements peak spreading by shifting the baseline starting point. A survey of the present-day ambient traffic peaking on or at critical facilities, followed by comparison with a baseline of documented historical peaking data, would be a good beginning for addressing this question.

Sources: O'Malley, B. W., and Selinger, C. S., "Staggered Work Hours in Manhattan." *Traffic Engineering and Control.* Printerhall Limited, London, U.K. (January, 1973). • Introductory and concluding comments by the Handbook authors.

Lloyd District Travel Demand Management—Portland, Oregon

Situation. The Lloyd District is a medium-to-high-density commercial and residential area of Portland, Oregon, located just east of the Central Business District (CBD) across the Willamette River. Once predominately a low-rise residential area, its development into a mixed-use activity center on its own right accelerated in the late 1980s with the introduction of MAX light rail transit (LRT) service. In addition to the Lloyd Center Shopping Mall, the Lloyd District became home to high-density retail streets, as well as the Oregon Convention Center, the Rose Garden Arena, and the Memorial Coliseum. Shoppers, event goers, employees, and residents found themselves competing for increasingly scarce on- and off-street parking with commuters to downtown Portland, who were parking at free on-street spaces and then riding transit into the CBD. This situation was not only producing traffic and parking problems in the Lloyd District, but also undermining the region's transportation goal of reducing SOV use for commuting to the downtown.

In 1990, the City of Portland, along with a coalition of downtown business interests, the Portland Development Commission, the regional transit agency (TriMet), and the regional planning organization (Metro), began development of the Central City Transportation Management Plan. This plan had as its goal providing for 75,000 new jobs and 15,000 new housing units in the central city by 2010. As part of its structure, the plan divided the city into eight districts. The Lloyd District was one of these districts and, because of its proximity to the CBD, was expected to capture 20 percent of the new jobs and 13 percent of the new housing units.

Actions. In September of 1997 the City of Portland, in concert with TriMet and the Lloyd District's Transportation Management Association (LDTMA), implemented the Lloyd District Partnership Plan (LDPP). The plan was specifically aimed at curbing SOV use for the commute to and from the Lloyd District. Adding further impetus to the plan was the establishment of the Employee Commute Options (ECO) Rule by the Oregon Department of Environmental Quality in 1996, requiring the implementation of trip reduction measures in order to maintain National Ambient Air Quality Standards. The ECO rule required any employer of 50 or more employees to develop a plan for achieving a 10 percent reduction in work-destined vehicle trips within a 3-year time frame. Participation in the LDPP lifted many of the ECO requirements for individual worksites in return for supporting district-wide measures such as limiting and charging for parking.

The LDPP included six major elements: (1) transit service improvements, including three direct express bus routes to the Lloyd District business core; (2) infrastructure improvements providing for a concentration of passengers and buses, convenience of transfers, and passenger amenities; (3) rideshare and bicycle improvements; (4) parking management strategies, including parking meters on most streets within the district, limitations on new parking supply, maximum parking ratios, and carpool metered spaces; (5) TDM strategies including the TriMet PASSport discount pass program, emergency ride home, and communication and promotion activities; and (6) program evaluation consistent with ECO rule requirements.

Analysis. A study was undertaken, as part of the City of Portland's assessment obligation, by Portland State University. A survey was conducted involving 259 employers in the Lloyd District, inquiring as to whether the way they usually got to work changed since the parking meters were installed in August 1997. A retrospective approach was necessary because the evaluation project was not commissioned until 1998, 1 year after the LDPP was implemented. The sample of employers equated to 19 percent of Lloyd District's 1,370 employers. A survey was mailed to all employees in the set of 233 employers having 49 or fewer employees, representing 545 employees total, and to a random sample of about 50 percent of the 26 employers with 50 or more employees. In all, 1,000 surveys were sent out, and 519 were returned and deemed valid for analysis. Out of the 519 total respondents, 400 answered the question of whether they had changed the way that they got to work, with 23 percent indicating that a change in mode had occurred.

Results. The survey returns were divided into three groups: all respondents, respondents whose employers participated in the PASSport program, and those whose employers did not participate in PASSport. (As presented earlier in this chapter, PASSport is a mechanism through which employers can help discount the cost of transit passes for their employees.) It was found that for all respondents, driving alone decreased by 7 percent (from 60 percent to 56 percent), with most of the shift going to carpooling, which increased by 38 percent (from 12 percent to 17 percent), while transit retained its existing share of about 19 percent. Walking, biking, and "other" showed insubstantial increases. For those respondents whose employer participated in PASSport, drive alone decreased by 19 percent and, again, a majority of those shifting went to carpooling, which increased by 41 percent. Transit share did see a 12 percent increase within this group, while walk/bike/other changed negligibly. Mode shares among the non-PASSport employees showed a 2 percent increase in drive-alone mode and a 36 percent decrease in transit, although carpooling still increased by 20 percent. The reason for this may have to do with the special carpool parking provisions discussed next.

When the parking meters were installed in the Lloyd District in the fall of 1997, the rate on most streets was $0.75 per hour for a 2-hour limit, 20 to 30 percent less than meter pricing in the CBD. Long-term (5-hour) meters were installed at the outer fringes of the District, reserved until 10:00 AM for carpoolers, who were required to display a special permit costing $30/month. Thereafter the cost was $0.35/hour.

A key finding was that most employees in the Lloyd District responded to the introduction of parking meters not by diverting to another mode, but by demonstrating a willingness to pay for what was once free. Use of the on-street carpool spaces remained low in terms of the proportion of all those who drove and parked (less than 1 percent for the entire sample). Of those who drove and parked, the percentage who parked in off-street parking—either employer-provided or commercial—increased. Data indicate that before the meters were introduced, 61 percent of employees who drove and parked in the District paid nothing to park. This percentage declined to 46 percent after the meters. However, the average price for those employees who paid something to park only increased from $0.34 to $0.37 per hour. Among the PASSport employees, 47 percent parked free before the meters versus 28 percent after, while the average cost for those who paid increased from $0.34 to $0.36 per hour.

The survey asked employees to rank the top three reasons for changes, if any, in travel behavior. The greatest share, 25 percent, indicated that their reason for shifting was unconnected to any TDM measure, but rather reflected a change in lifestyle. The next largest share, 22 percent, said that installation of the parking meters was their No. 1 reason for changing, followed by 19 percent who said that the PASSport program was their top reason. In ranking their No. 2 reasons for change, nearly 36 percent of employees who changed behavior cited the PASSport program, while about 7 percent cited parking meters as their second reason.

More . . . A policy of seeking Lloyd District employee input is credited with having enhanced TDM program impacts over time. As part of periodic LDTMA surveys, employees are queried about their perceived needs. This information is fed back to participating employers and also guides LDTMA prioritization of new bus service. Additional bus service is offered in direct response to Lloyd District transit ridership growth.

VTPI's *Online TDM Encyclopedia* presents updated information on mode split in the Lloyd District, which suggests a deepening of impact both in SOV trip reduction and in a positive shift toward transit use as the preferred alternative. These 2005 data indicate a drive-alone share down to 43 percent from 60 percent in 1997, transit at 39 percent mode share versus 21 percent in 1997, and ridesharing at 11 percent compared to 16 percent in 1997. The 2005 statistics also indicate that biking and walking have stayed about the same, at around 3 percent and 2 percent, respectively, while telecommuting and compressed work week (CWW) use has increased from 0.5 percent or less to just under 1 percent each.

TDM was undoubtedly not the sole cause of the 1997–2005 shift toward transit use. In 1998, the MAX Blue Line (the east-west LRT service running through the Lloyd District) was extended into the west suburbs of Portland. In 2001, Lloyd District Blue Line service was augmented with MAX Red Line trains to the airport. In 2004, the connecting MAX Yellow Line serving Northeast Portland was opened through the western edge of the district.

Sources: Bianco, M. J., "Effective Transportation Demand Management: Combining Parking Pricing, Transit Incentives, and Transportation Management in a Commercial District of Portland, Oregon." *Transportation Research Record 1711* (2000). • Hillsman, E. L., Center for Urban Transportation Research, University of South Florida. Email to the Handbook authors. Tampa, FL (January 16, 2009).

• Victoria Transport Policy Institute, "Transportation Management Associations," *Online TDM Encyclopedia.* Victoria, BC, Canada. http://www.vtpi.org/tdm/tdm44.htm (Webpage updated July 26, 2008). • TriMet, "MAX Light Rail Project History." http://trimet.org/about/history/maxoverview.htm (Website accessed June 3, 2009).

Overall TDM Program Effects over Time—Bellevue, Washington

Situation. The City of Bellevue is located across Lake Washington from Seattle. It is a suburb that since the late 1970s has sought to foster TDM through its employers, undergirded by municipal and state development regulations, and with support of transit improvements. TDM-related case studies covering individual Bellevue employers are found in Chapter 13, "Parking Pricing and Fees" (see "US WEST Parking Pricing and Management"), and Chapter 18, "Parking Management and Supply" (see "CH2M Hill Employee Parking Management"). This Chapter 19 case study, as an adjunct to the "Site- Versus System-Level Impacts" discussion in the "Related Information and Impacts" section, seeks to ferret out the combined effects of employer TDM strategies and public strategies on overall commuting to downtown Bellevue.

Downtown Bellevue is relatively unique for a suburban activity center. The rectangle encompassing the downtown, approximately 3/4 of a mile on a side, had over 23,000 workers in 1986—60 percent of them office workers—and a 1.3 million square foot regional shopping center.[22] The street system is an imperfect grid, with most streets forming superblocks 600 feet on a side. Building setbacks are reduced compared to the suburban norm. I-405, linking the Seattle area's east-side suburbs, is on the east side of downtown Bellevue.

Actions. Bellevue operated between 1981 and 1986 under an incentive agreement between Seattle Metro (now King County Metro) and the City of Bellevue whereby Bellevue was rewarded with additional transit services in return for increasing employer densities and obtaining lower parking ratios in the downtown. The city continues to incorporate transportation demand management programs (TMPs) into new development approval conditions. Employment density has increased, with 34,250 downtown jobs in 2000, up almost 50 percent in 14 years. The ratio of parking to floor space allowed in new buildings is roughly one-half the minimum that applied prior to 1979, and individual employers have made parking pricing a part of their TMPs (see the case studies noted above in Chapters 13 and 18). During the 1987–1989 period, a Transportation Management Association (TMA) was established and HOV marketing, vanpool incentive, and guaranteed ride home (GRH) programs were tested, enhanced, and incorporated into the overall program. Over time the HOV and transit use incentives/subsidies have evolved regionally into Metro's heavily marketed FlexPass program of partnerships with employers (see "Response by Type of Strategy"—"Changes in Fare Categories"—"Unlimited Travel Pass Partnerships" in Chapter 12, "Transit Pricing and Fares"). Passage of Washington State's Commute Trip Reduction (CTR) Law, and the implementation of mandatory elements specific to Bellevue, further undergirds the Bellevue program.

Specific bus service improvements have included restructuring and expansion over the years. The Bellevue Transit Center was opened in 1985. In the 1987–1989 time frame, almost one-half the bus services in the Eastside area including Bellevue were reorganized with the objective of establishing

[22] Many downtown Bellevue statistics, particularly the newer ones, are for a slightly larger area, either a 1- × 3/4-mile rectangle that encompasses I-405 and the Bellevue interchange on the east, or an in-between-sized area covering the westerly half of I-405 and the interchange.

a true Eastside Transit System. (One service approach tried and discarded was the provision of a Downtown Bellevue bus circulator, as described in Chapter 10, "Bus Routing and Coverage," under "Response by Type of Service and Strategy"—"Circulator/Distributor Routes"—"Workplace to Retail and Restaurants Circulators.") In the late 1990s, the suburban bus services of King County Metro overall were reorganized into a multi-centered "hub and spoke" system that more comprehensively focused on selected non-Downtown Seattle employment areas while still serving the Seattle CBD. Core route frequencies and service hours were enhanced. Bellevue was the largest of the suburban employment center hubs where essentially all routes were brought through or terminated at the central transit center. The Bellevue/Seattle-CBD and Bellevue/University-District core routes were among those extensively improved for all-day bi-directional service with multi-destination connections (see the case study, "Service Restructuring and New Services in Metropolitan Seattle," in Chapter 10).

Analysis. The primary measure of downtown Bellevue TDM impact available over a 20-plus-year time period is downtown employee commute mode shares. Those presented under "Results" in Table 19-40 have been obtained from periodic survey efforts which, in contrast to the more frequent CTR reportings, cover essentially all downtown Bellevue employers rather than just those large enough to be under CTR reporting requirements. (The more recent comprehensive surveys have made use of CTR reportings, combining them with supplemental surveys to obtain the broader picture.) The surveys have differences among them in methodology, highlighted in the Table 19-40 footnotes. These differences produce inconsistencies that make mode share comparisons between surveys somewhat problematical, requiring extra caution in results interpretation. The downtown survey mode share data has been supplemented by U.S. Census "usual" commute mode results, along with additional information assembled to support a descriptive analysis, most particularly data specially developed by King County Metro on Bellevue transit service levels and ridership over the 1994–2005 period.

Results. Table 19-40 presents the 1984–2005 downtown Bellevue comprehensive mode share survey results discussed above. The U.S. Census Transportation Planning Package (CTPP) provides similar data, but for fewer years. Downtown Bellevue "usual" commute mode shares from the CTPP for 1980, 1990, and 2000, respectively, were 79, 82, and 77 percent drive alone, 4.7, 5.1, and 8.0 percent transit, and 14, 12, and 13 percent carpool. All other modes were individually less than 0.5 percent, except walk. The reported 1980, 1990, and 2000 walk shares were 2.2, 0.4, and 1.5 percent, respectively.[23]

[23] The walk shares pattern suggests that variations related to CTPP procedures, including sample size, may well be overwhelming trends or indications of stability. Also, the pattern of CTPP transit shares does not seem to track ridership data presented below in Table 19-41 as well as the downtown Bellevue survey transit shares in Table 19-40.

Table 19-40 Surveyed Commute Mode Shares (Percent) to Downtown Bellevue over Time

Modes	1984	1990	1996	2000	2003	2005
Drive Alone	79%	80%	76%	68%	68%	71%
Bus	6	7	7	13	12	14
Carpool	13	10	14	17	12	10
Vanpool	–	<1	–	–	2	1
Walk	–	–	–	–	2	2
Bike	–	–	–	–	1	1
Compressed	–	–	–	–	2	<1
Telework	–	–	–	–	1	2
Other	2	3	3	2	1	1

Notes: Changes in methodology from survey to survey render mode share comparisons problematical, especially among the 1984-2000 surveys.

Workers in 1984 were asked to list all commute modes used. In 1990 they were asked their typical commute mode, as is done in the U.S. Census. The procedures documentation for 1996 was not available. Mode shares for 2000-2005 were based on worker reporting of modes used for each commute during the previous week.

The 1984 all-commute mode shares provided here have been approximated by the Handbook authors — starting with the 1984 multiple-responses-allowed office-commute shares of 77.7 percent drive alone, 7.4 percent bus, 16.2 percent carpool, and 2.1 percent other — by normalizing to 100 percent to compensate for the multiple-responses-allowed survey procedure and then factoring by the 1990 mode-by-mode all-commute to office-commute share ratios.

Where vanpool shares are not provided, vanpools were included with carpools. Where walk, bike, CWW, and telework shares are not provided, they may be assumed to be included within "other." For 1990, "Multi-mode" and "No typical mode" have been added to "other."

The downtown Bellevue survey results seem to suggest moderately consistent trends for both the drive-alone and transit commute modes, downward over time in the case of drive alone, and upward for transit. The CTPP results seem to exhibit a lack of strong, consistent trends for all modes except transit. Together, the two data sources suggest a 20-year drive-alone commute share reduction—over somewhat different time spans—of somewhere between 10 percent (downtown surveys) and 2 percent (CTPP). Corresponding transit share increases are in the range of 133 percent (downtown surveys) to 70 percent (CTPP), roughly a doubling. (As noted in Footnote 23, the downtown survey findings are better supported by transit ridership data than the CTPP findings.) Carpool use shows no consistency over time in the mode share data. Despite efforts to improve the pedestrian environment, rendered less than optimal by busy streets, walking to work has shown no upward (or downward) trend.

More . . . It is useful, in interpreting the mode share results over time, to examine how effective the overall Bellevue TDM program has been in achieving public transit improvement and parking management. Measures of bus service improvement and usage are illustrated in Table 19-41 for the 1996–2005 time period. Table 19-42 provides downtown Bellevue off-street parking inventory information for the 1987–2006 period. The parking inventory encompasses more than just employee parking—motor pool and customer parking are included—but provides at least an indication of parking supply and pricing trends.

Table 19-41 Downtown Bellevue AM Peak-Period Transit Service and Ridership

Measure	1996	2000	2005
DB Bus Arrivals – King County Routes	106	113	151
DB Bus Arrivals – Snohomish County Routes	4	10	10
DB Passenger Alightings – King County Routes	982	1,678	1,805
DB Passenger Alightings – Snohomish Co. Routes	n/a	n/a	n/a

Notes: AM peak defined as 6:00 AM to 9:00 AM.

DB = Downtown Bellevue.

Passenger alightings include transfer passengers.

Downtown Bellevue passenger alightings on King County routes grew to 2,219 in 2007. A possible contributing factor (and example of exogenous influences) is an improvement in the Bellevue CBD office vacancy rate from 9.12 percent in 2005 (11.07 percent in 2004) to 6.00 percent in 2007.

Table 19-42 Downtown Bellevue Off-Street Parking Inventory Findings

Measure	1987	1992	1996	2002	2006
DB Total Spaces	26,943	29,447	31,093	32,623	34,075
DB Occupancy Rate	54.3%	61.0%	61.1%	56.6%	55.3%
DB Average Daily Fee	$6.06	$6.58	$6.90	$11.30	$12.66
Same, Seattle CBD	$7.50	$10.00	$12.12	$14.52	$21.33

Notes: Space count includes employee and customer, motor pool, free and pay, and public and private off-street parking.

DB = Downtown Bellevue.

Average Daily Fee is a weighted average for pay parking only, in current (not constant) dollars. At least up through 1996, 80 percent of downtown Bellevue parking spaces were free.

The 1996–2005 transit service and ridership data in Table 19-41 illustrate that transit service improvement intentions have been followed through on and have been accompanied by increased ridership. The fact that AM bus arrivals in downtown Bellevue—a measure of bus service intensity—increased most between 2000 and 2005, while ridership increased most between 1996 and 2000, stands out as an apparent anomaly. However, the Chapter 10 case study, “Service Restructuring and New Services in Metropolitan Seattle,” presents evidence that the jump in ridership was strongly related to a well-received late 1990s service restructuring into a fully formed “hub and spoke” operating pattern that allowed a major focus on serving suburban employment centers. For example, key trunk-line bus routes serving downtown Bellevue achieved 6 to 30 percent productivity increases (weekday passengers per hour of bus service) between 1994 and 1998.

The 1987–2006 off-street parking data in Table 19-42 are a little harder to relate to employer responses to TDM, given that substantial non-employer parking is not separately identified. Nevertheless, the fact that an almost 50 percent increase in employment between 1986 and 2000 was accompanied by only a 21 percent increase in downtown parking spaces between 1987 and 2002 is strongly suggestive of a tightening parking supply. The doubling of all-day parking fees between 1987 and 2006, even though it is less than the near-tripling of fees in the Seattle CBD (provided for comparison), is also suggestive of demand management progress. The major post-1996 jump in all-day parking fees and its correspondence with the sharpest transit ridership and transit share increases, and the sharpest drive-alone share decrease, gives added credence to the apparent importance of parking-related employer TDM actions along with the public transit improvements in achieving vehicle trip reduction.

Table 19-42 gives only a hint of parking price plateauing in the 2002–2006 period. Both the amount and cost of priced employee parking tended to decrease at employers with building leases negotiated in the 2001–2003 period following the "dot-com bust," which resulted in a period of high downtown Bellevue office vacancy rates. CTR survey results (not reported here) suggest a corresponding lagged response in the form of higher drive-alone mode shares and diminished carpooling. The 2005 surveyed commute mode shares in Table 19-41 are thus likely not a survey anomaly but instead a true reflection of mode shift "backsliding" traceable back through parking pricing to economic conditions.

The overall downtown 20-year drive-alone commute reduction of 10 percent (or 2 percent per the CTPP results) represents a diffusion of higher reductions obtained at individual employment sites. Bellevue City Hall, CH2M Hill, and US WEST are examples of individual sites achieving estimated employee VTRs on the order of 30 percent or more.[24] Performance at other involved employers was for the most part less dramatic. Throughout the 1980s, at least, gains in transit and ridesharing use in the downtown were limited primarily to those employers that located in Bellevue post-1980, suggesting the critical importance of the TMP-mandated parking management. Only post-1980 employers were compelled by formal city requirements to constrain parking supply. The TMA successfully gained broad membership, financing, and recognition, but not a broad commitment toward substantive TDM program actions. The municipal TMP and more recent state CTR requirements have served as the primary impetus for stronger TDM actions.

Sources: Kuzmyak, J. R., and Schreffler, E. N., *Evaluation of Travel Demand Management (TDM) Measures to Relieve Congestion.* Prepared by Comsis Corporation and Harold Katz & Associates for the Federal Highway Administration, U.S. Department of Transportation (February, 1990). • Samdahl, D. R., and Kenyon, K. L., *Learning and Leading: Transportation Demand Management in Bellevue, Washington.* City of Bellevue, WA (February, 1991). • Comsis Corporation, "A Case Study of the Experience of Seattle Metro in Fostering Suburban Mobility." Prepared for the Urban Mass Transportation Administration, U.S. Department of Transportation. Silver Spring, MD (September, 1991). • Bellevue Economic Profile, "Employment" (May, 2005). • Washington State Department of Transportation, "TDM—Commute Trip Reduction (CTR): Commute Trip Reduction Results—It Works." http://www.wsdot.wa.gov/TDM/CTR/CTRworks.htm (Webpage dated 2007). • DKS Associates and Mirai Associates, "Modeling TDM Effectiveness: Developing a TDM Effectiveness Estimation Methodology (TEEM) and Case Studies for the SR 520 Corridor." Final Report and Version 5 draft "Downtown Bellevue" case study. Prepared for the Washington State Department of Transportation (April, 2003). • Gilmore Research Group, "1990 Bellevue CBD Transportation Mode Use Study." Prepared for City of Bellevue

[24] These site-specific vehicle trip reductions are calculated not from time-series data, but instead by comparison with neighboring employment areas.

(January, 1991). • Pacific Rim Resources, Inc., "City of Bellevue Mode Split: Downtown Bellevue District." Prepared for City of Bellevue Transportation Department (December 15, 2000). • Northwest Research Group, Inc., "2005 Mode Share Summary Report." Prepared for City of Bellevue (June, 2006). • Puget Sound Regional Council, "Commuting to the Region's Downtown Areas." *Puget Sound Trends* (March, 2004). • Whisner, J., King County Metro. Email to the Handbook authors with attached Excel file containing fall 1994, 2000, and 2004 "signup" run data for services to downtown Bellevue (October 5 and 15, 2007). • Community Transit [1994] and Sound Transit public bus schedules for Snohomish County to Bellevue routes (February 1994; September 2000; and September 2005). • Wold, M., King County Metro. Email to the Handbook authors with attached BelDTZones.xls file containing fall 1994, 2000, and 2004 downtown Bellevue AM Peak Period passenger alighting counts (January 18, 2008). • Puget Sound Regional Council, "Downtown Seattle and Bellevue Parking Trends, 1987–1996." *Puget Sound Trends* (March, 1997). • Puget Sound Regional Council, "Parking Trends for the Central Puget Sound Region, 1996–2002." *Puget Sound Trends* (February 2003). • Puget Sound Regional Council, "Parking Trends for the Central Puget Sound Region, 2004–2006." *Puget Sound Trends* (January, 2007). • Clark, J., City of Bellevue. Email to the Handbook authors with 2004–2007 "Office Vacancy Data for Bellevue CBD" (April 23, 2008). • Hillsman, E. L., Center for Urban Transportation Research, University of South Florida. Email to the Handbook authors. Tampa, FL (January 16, 2009). • Downtown Bellevue AM peak period bus arrival and passenger alightings summarizations, and certain case study concluding observations, by the Handbook authors.

REFERENCES

Associated Press, *International Herald Tribune.* Business Section (January 7, 2003).

Association for Commuter Transportation, Urbantrans Consultants, PB Parsons Brinckerhoff, and ESTC, "Mitigating Traffic Congestion: The Role of Demand-Side Strategies." In partnership with the Federal Highway Administration, U.S. Department of Transportation. http://www.ops.fhwa.dot.gov/publications/mitig_traf_cong/ (2004).

Atherton, T., Scheuernstuhl, G. J., and Hawkins, D., "Transportation-Related Impacts of Compressed Work Week: The Denver Experiment." *Transportation Research Record 845* (1982).

Bellevue Economic Profile, "Employment" (May, 2005).

Beraldo, S., "Bishop Ranch 1990 Transportation Survey." *Bay Area RIDES,* Oakland, CA (December, 1990).

Bianco, M. J., "Effective Transportation Demand Management: Combining Parking Pricing, Transit Incentives, and Transportation Management in a Commercial District of Portland, Oregon." *Transportation Research Record 1711* (2000).

Burch, D., *1988 Database Survey.* RIDES for Bay Area Commuters, Inc., Oakland, CA (December, 1988).

Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A., and Goodwin, P., *Transport for Quality of Life.* Final Report to the Department for Transport, London, U.K. (2002).

Cambridge Systematics, Inc., "Denver Federal Employee Compressed Work Week Experiment—Evaluation of Transportation Related Impacts." Prepared for Denver Regional Council of Governments (September, 1980).

Cambridge Systematics, Inc., "The Effects of Land Use and TDM Strategies on Commuting Behavior." Federal Highway Administration, U.S. Department of Transportation (1994).

Center for Transportation and the Environment., "The Clean Air Campaign: Cash for Commuters Program—Report on November 2004 Follow-Up Survey." Prepared in cooperation with Georgia Department of Transportation and Federal Highway Administration (2004).

Center for Urban Transportation Research, "Worksite Trip Reduction Model and Manual." University of South Florida, Tampa (April, 2004).

Cervero, R., *America's Suburban Centers: A Study of the Land Use-Transportation Link.* Urban Mass Transit Administration, U.S. Department of Transportation (1988).

Clark, J., City of Bellevue. Email to the Handbook authors with 2004–2007 "Office Vacancy Data for Bellevue CBD" (April 23, 2008).

Committee for the Evaluation of the Congestion Mitigation and Air Quality Improvement Program, "The Congestion Mitigation and Air Quality Improvement Program—Assessing 10 Years of Experience." *Special Report 264.* Transportation Research Board, Washington, DC (2002).

Comsis Corporation, "A Case Study of the Experience of Seattle Metro in Fostering Suburban Mobility." Prepared for the Urban Mass Transportation Administration, U.S. Department of Transportation. Silver Spring, MD (September, 1991).

Comsis Corporation, "A Survey and Analysis of Employee Responses to Employer-Sponsored Trip Reduction Incentive Programs—Technical Appendix A—Model Calibration Report." Draft Final Report. Prepared for the California Air Resources Board (1993a).

Comsis Corporation, "Task 2 Working Paper: An Examination of Cost/Benefit and Other Decision Factors Used in Design of Employer-Based TDM Programs." TCRP Project B-4. Unpublished research findings and associated data files, Transportation Research Board, Washington, DC (1994).

Comsis Corporation, "Travel Demand Management Program User's Guide." Prepared for South Coast Air Quality Management District (1993b).

Comsis Corporation and C. Pansing Transportation Consultant, "MTA Transportation Demand Management Evaluation." Final Report. Prepared for Los Angeles County Metropolitan Transportation Authority (1997).

Comsis Corporation and Institute of Transportation Engineers, "Implementing Effective Travel Demand Management Measures: Inventory of Measures and Synthesis of Experience." Prepared for Federal Highway Administration and Federal Transit Administration, Washington, DC (1993).

Comsis Corporation, E. N. Schreffler Transportation Consultant, K.T. Analytics, Applied Management and Planning Group, Crain & Associates, David A. Puzo & Associates, and Parsons Brinckerhoff Quade & Douglas, Inc., "MTA TDM Demonstration Program Third-Party Evaluation." Final Report. Prepared for Los Angeles County Metropolitan Transportation Authority (1996).

Concas, S., and Winters, P. L., "Quantifying the Net Social Benefits of Vehicle Trip Reductions: Guidance for Customizing the TRIMMS© Model." Final Draft Report. Prepared by Center for Urban

Transportation Research, University of South Florida, Tampa, FL. http://www.nctr.usf.edu/abstracts/abs77805.htm (April, 2009).

Davidson, D., "Impact of Suburban Employee Trip Chaining on Transportation Demand Management." *Transportation Research Record 1321* (1991).

Dill, J., "Mandatory Employer-Based Trip Reduction—What Happened?" *Transportation Research Record 1618* (1998).

Dill, J., and Wardell, E., "Factors Affecting Work Site Mode Choice: Findings from Portland, OR." *Transportation Research Record 1994* (2007).

DKS Associates and Mirai Associates, "Modeling TDM Effectiveness: Developing a TDM Effectiveness Estimation Methodology (TEEM) and Case Studies for the SR 520 Corridor." Final Report and Version 5 draft "Downtown Bellevue" case study. Prepared for the Washington State Department of Transportation (April, 2003).

Dowling, R., Feltham, D., and Wycko, W., "Factors Affecting Transportation Demand Management Program Effectiveness at Six San Francisco Medical Institutions." *Transportation Research Record 1321* (1991).

Enoch, M., and Zhang, L., Chapter 12, "Travel Plans." In *The Implementation and Effectiveness of Transport Demand Measures—An International Perspective* (S. Ison and T. Ashgate Rye, eds.), Publishing Limited, Aldershot, Hampshire, England (2008).

Freas, A. M., and Anderson, S. M., "Effects of Variable Work Hour Programs on Ridesharing and Organizational Effectiveness: A Case Study, Ventura County." *Transportation Research Record 1321* (1991).

Georggi, N. L., Winters, P., Rai, S., and Zhou, L., "Measuring the Impacts of Employer-based Transportation Demand Management Programs on an Interstate Corridor." *Journal of Public Transportation,* Vol. 10, No. 4—Special Edition: TDM. Center for Urban Transportation Research, Tampa, FL (2007).

Gilmore Research Group, "1990 Bellevue CBD Transportation Mode Use Study." Prepared for City of Bellevue (January, 1991).

Giuliano, G., "Transportation Demand Management: Promise or Panacea?" *APA Journal,* Vol. 58, No. 3 (1992).

Hansen, M., and Slachowitz, M., "Metro Commute Partnerships." 2001 ACT International Conference Presentation, King County Metro Transit/Market Development Group, Seattle, WA (July, 2001).

Harrison, F., Jones, D., and Jovanis, P., *Flextime and Commuting Behavior in San Francisco: Some Preliminary Findings.* Summary Report, Institute of Transportation Studies, University of California, Berkeley, CA (1979).

Hendricks, S. J., and Joshi, A., *Commuter Choice Program Case Study Development and Analysis.* Center for Urban Transportation Research, University of South Florida, Tampa, FL (2004).

Hillsman, E. L., Center for Urban Transportation Research, University of South Florida. Email to the Handbook authors. Tampa, FL (January 16, 2009).

ICF Consulting, Center for Urban Transportation Research, Nelson\Nygaard, and ESTC, "Strategies for Increasing the Effectiveness of Commuter Benefits Programs." *TCRP Report 90*, Transportation Research Board, Washington, DC (2003).

Institute of Transportation Engineers, "Areawide Travel Demand Management Programs. A Guidance Manual." Washington, DC (October, 1992a).

Institute of Transportation Engineers, "Implementing Effective Employer-Based Travel Demand Management Programs. A Guidance Manual." Washington, DC (November, 1993).

Institute of Transportation Engineers, "Marketing Research for Transportation Demand Management Programs. A Guidance Manual." Washington, DC (November, 1992b).

Institute of Transportation Engineers, "Transportation Funding Available Through the Energy Efficiency and Conservation Block Grant Program." *ITE E-newsletter* (April 6, 2009).

Ison, S., and Rye, T., Chapter 1, "Introduction: TDM Measures and their Implementation," in *The Implementation and Effectiveness of Transport Demand Measures—An International Perspective.* Ashgate Publishing Limited, Aldershot, Hampshire, England (2008).

Jewell, M., and Schwenk, J., *Evaluation of the Baltimore Guaranteed Ride Home Program.* Final Report. Federal Transit Administration, U.S. Department of Transportation (December, 1994).

JHK & Associates, "Final Report: Cost-Effectiveness Study of TSM Measures in Suburban Settings." Prepared for City of Pleasanton and Federal Transit Administration (1992).

Jones, D., "Off Work Early." Institute of Transportation Studies, University of California at Berkeley (February, 1983).

Jovanis, P. P., and May, A. D., *Flextime Travel: Research Framework and Preliminary Findings.* Institute of Transportation Studies, University of California, Berkeley, CA (August, 1979).

Kitamura, R., Niles, J. M., Conroy, P., and Fleming, D. M., "Telecommuting as a Transportation Planning Measure: Initial Results of State of California Pilot Project." *Transportation Research Record 1285* (1990).

Kuzmyak, J. R., and Schreffler, E. N., *Evaluation of Travel Demand Management (TDM) Measures to Relieve Congestion.* Prepared by Comsis Corporation and Harold Katz & Associates for the Federal Highway Administration, U.S. Department of Transportation (February, 1990).

LDA Consulting, "Transportation Emission Reduction Measure (TERM) Analysis Report." Prepared for Metropolitan Washington Council of Governments (1999).

Los Angeles County Metropolitan Transportation Authority, "The Bicycle Commuter Act." http://www.metro.net/projects_studies/bikeway_planning/biketowork/employers.htm (Webpage accessed May 29, 2009).

Lyons, G., Farag, S. and Haddad, H., Chapter 11, "The Substitution of Communications for Travel." In *The Implementation and Effectiveness of Transport Demand Measures—An International Perspective* (S. Ison and T. Ashgate Rye, eds.), Publishing Limited, Aldershot, Hampshire, England (2008).

Metropolitan Washington Council of Governments, "State of the Commute 2001: Survey Results from the Washington Metropolitan Region." Washington, DC (July, 2002).

Mokhtarian, P. L., "A Synthetic Approach to Estimating the Impacts of Telecommuting on Travel." *Urban Studies,* Vol. 35, No. 2 (1998).

Municipality of Metropolitan Seattle, "HOV/TSM Evaluation Study." Final Report. Transit Department, Research and Market Strategy Division, Seattle, WA (1990).

Nelson\Nygaard Consulting Associates and Westat, "Car Sharing: Where and How It Succeeds." *TCRP Report 108.* Transportation Research Board, Washington, DC (2005).

Northwest Research Group, Inc., "2005 Mode Share Summary Report." Prepared for City of Bellevue (June, 2006).

O'Malley, B. W., and Selinger, C. S., "Staggered Work Hours in Manhattan." *Traffic Engineering and Control.* Printerhall Limited, London, U.K. (January, 1973).

Orski, C. K., "Employee Trip Reduction Programs—An Evaluation." *Transportation Quarterly,* Vol. 47, No. 3 (July, 1993).

Ott, M., Slavin, H., and Ward, D., *The Behavioral Impacts of Flexible Working Hours.* TSC Urban & Regional Research Series. Transportation Systems Center (now Volpe Center), Cambridge, MA (January, 1980).

Pacific Rim Resources, Inc., "City of Bellevue Mode Split: Downtown Bellevue District." Prepared for City of Bellevue Transportation Department (December 15, 2000).

Pansing, C., Schreffler, E. N., and Sillings, M. A., "Comparative Evaluation of the Cost-Effectiveness of 58 Transportation Control Measures." *Transportation Research Record 1641* (1998).

Polena, C., and Glazer, L. J., "Examination of 11 Guaranteed Ride Home Programs Nationwide." *Transportation Research Record 1321* (1991).

Port Authority of New York and New Jersey, Planning and Development Department, "Flexible Work Hours Experiment at the Port Authority of New York and New Jersey. 1974–1975." Urban Mass Transit Administration, U.S. Department of Transportation (1975).

Pratt, R. H., *Documentation of Experience-Based TDM Model Mode Shifts and Voluntary Employer Participation Rates.* Memorandum to FHWA TDM Project File (February 2, 1992).

Pratt, R. H., "Planning Solutions—TDM and Beyond." Transportation Research Board 1988 Stone Mountain Conference on Transportation for Suburban and Activity Center Locations. *Transportation Research Circular 359* (1990).

Pratt, R. H., and Copple, J. N., *Traveler Response to Transportation System Changes.* Second Edition. Federal Highway Administration, U.S. Department of Transportation, Washington, DC (July, 1981).

Pratt, R. H., Pedersen, N. J., and Mather, J. J., *Traveler Response to Transportation System Changes—A Handbook for Transportation Planners* [first edition]. Federal Highway Administration, U.S. Department of Transportation, Washington, DC (February, 1977).

Puget Sound Regional Council, "Commuting to the Region's Downtown Areas." *Puget Sound Trends.* Seattle, WA (March, 2004).

Puget Sound Regional Council, "Downtown Seattle and Bellevue Parking Trends, 1987–1996." *Puget Sound Trends.* Seattle, WA (March, 1997).

Puget Sound Regional Council, "Parking Trends for the Central Puget Sound Region, 1996–2002." *Puget Sound Trends.* Seattle, WA (February, 2003).

Puget Sound Regional Council, "Parking Trends for the Central Puget Sound Region, 2004–2006." *Puget Sound Trends.* Seattle, WA (January, 2007).

Rathbone, D. B., "Telecommuting in the United States." *ITE Journal,* Vol. 62, No. 12. Institute of Transportation Engineers, Washington, DC (December, 1992).

Rutherford, G. S., Badgett, S. I., Ishimaru, J. M., and MacLachlan, S., "Transportation Demand Management: Case Studies of Medium-Sized Employers." *Transportation Research Record 1459* (1994).

Safavian, R., and McLean, K. G., "Variable Work Hours: Who Benefits." *Traffic Engineering,* Vol. 45, No. 3. Institute of Transportation Engineers, Washington, DC (March, 1975).

Samdahl, D. R., and Kenyon, K. L., *Learning and Leading: Transportation Demand Management in Bellevue, Washington.* City of Bellevue, WA (February, 1991).

Schreffler, E., *Evaluation of Trip Reduction Requirements: Findings and Recommendations.* Final Report. City of Sacramento, CA, Department of Public Works (January, 1997).

Schreffler, E. N., "How Costly and Cost Effective are ECO Programs?" *Compendium of Technical Papers for the 66th ITE Annual Meeting.* Institute of Transportation Engineers (September, 1996).

SG Associates, Inc., and Howard/Stein-Hudson Associates, Inc., "Cross Westchester Expressway Corridor Transportation Systems Management Program." Final Report. Westchester County Department of Transportation (March, 1993).

Shaheen, S. A., and Rodier, C. J., "Travel Effects of a Suburban Commuter Carsharing Service: CarLink Case Study." *Transportation Research Record 1927* (2005).

Shoup, D., *Evaluating the Effects of Parking Cash Out: Eight Case Studies.* Final Report. Prepared for California Air Resources Board Research Division, Sacramento, CA (1997).

Sierra Research, Inc., "COMMUTER Model: User Manual for Analysis of Voluntary Mobile Source Emissions Reduction and Commuter Choice Incentive Programs." U.S. Environmental Protection Agency (September, 1999).

Skinner, L. E., and Shea, C. G., *Impact of Compressed Work Schedules: Socio-Demographic and Attitudinal Factors and Travel Pattern Effects.* Federal Highway Administration, U.S. Department of Transportation, Washington, DC (March, 1981).

Southern California Association of Governments, "Evaluation Report: Telecommuting Pilot Project." Los Angeles, CA (August, 1988).

Spielberg, F., Bloch, A., Bogacz, G., and Johnson, V., *Evidence of the Effectiveness of Employer Sponsored Transportation Days.* Unpublished [1993].

Stewart, J., "Time Off With Pay as a TDM Incentive." *FACTS: Southern California.* Volume 7, Issue 7. Newsletter of Southern California Chapter of the Association for Commuter Transportation. Glendale, CA (1992).

Tang, W., Mokhtarian, P. L., and Handy, S. L., "The Impact of the Residential Built Environment on Work at Home Adoption and Frequency: An Example from Northern California." *TRB 86th Annual Meeting Compendium of Papers CD-ROM.* Washington, DC (January 21–25, 2007).

Teal, R., *Impact of TDM Marketing and Support Strategies in Maricopa County.* Maricopa County [Arizona] Trip Reduction Program. Prepared for Chicago Area Transportation Study (1993).

TransitCenter, Inc., "Stimulus Bill a Financial Victory for Nation's Mass Transit Riders." *PR Newswire.* http://www.coredocuments.com/docs/President_Obama_signs_Stimulus_Bill_wi th_%20new_$230_Transit_Benefit.pdf (February 19, 2009).

TriMet, "MAX Light Rail Project History." http://trimet.org/about/history/maxoverview.htm (Website accessed June 3, 2009).

TriMet, "Transportation Demand Management in the Portland Metropolitan Region." Portland, OR (2000).

University of Washington, "2005 U-PASS Annual Report." Transportation Office, Seattle, WA. http://www.washington.edu/upass/news_and_reports/upass_reports/annualreport2005.

Urban Transportation Monitor, "Portland TMA Survey Indicates that TMA Members' Employees Use Transit More Often than Non-TMA Employees." Vol. 16, No. 10 (May 31, 2002).

U.S. Census Bureau, "Statistics about Business Size (including Small Business)." http://www.census.gov/epcd/www/smallbus.html. (Website accessed June 4, 2007).

U.S. Department of Energy, "New Approaches to Successful Vanpooling: Five Case Studies." Assistant Secretary for Conservation and Solar Applications, Office of Transportation Programs (May, 1979).

U.S. Environmental Protection Agency, "Carpool Incentive Programs: Implementing Commuter Benefits as One of the Nation's Best Workplaces for Commuters." Office of Air and Radiation (November, 2005).

Valk, P., Transportation Management Services. Email to the Handbook authors. Pasadena, CA (August 6, 2007).

Victoria Transport Policy Institute, *Online TDM Encyclopedia.* Victoria, BC, Canada. http://www.vtpi.org/tdm/index.php (Webpage updated May, 2009).

Victoria Transport Policy Institute, "Transportation Management Associations," *Online TDM Encyclopedia.* Victoria, BC, Canada. http://www.vtpi.org/tdm/tdm44.htm (Webpage updated July 26, 2008).

Wachs, M., "Learning from Los Angeles: Transport, Urban Form, and Air Quality." *Transportation,* Vol. 20, No. 4 (1993).

Walls, M., Safirova, E., and Jiang, Y., "What Drives Telecommuting? Relative Impact of Worker Demographics, Employer Characteristics, and Job Types." *Transportation Research Record 2010* (2007).

Washington State Department of Transportation. "TDM—Commute Trip Reduction (CTR): Commute Trip Reduction Results—It Works." http://www.wsdot.wa.gov/TDM/CTR/CTRworks.htm (Webpage dated 2007).

Washington State Energy Office, "Puget Sound Telecommuting Demonstration." Executive Summary. Olympia, WA (November, 1992).

Wegmann, F., Chatterjee, A., and Stokey, S. R., "An Evaluation of an Employer-Based Commuter Ridesharing Program." *Special Report 184.* Transportation Research Board, Washington, DC (1979).

Wegmann, F. J., and Stokey, S. R., "Impact of Flexitime Work Schedules on an Employer-Based Ridesharing Program." *Transportation Research Record 914* (1983).

Whisner, J., King County Metro. Email to the Handbook authors with attached Excel file containing fall 1994, 2000, and 2004 "signup" run data for services to downtown Bellevue (October 5 and 15, 2007).

Wold, M., King County Metro. Email to the Handbook authors with attached BelDTZones.xls file containing fall 1994, 2000, and 2004 downtown Bellevue AM Peak Period passenger alighting counts (January 18, 2008).

Young, R., and Luo, R., "Five-Year Results of Employee Commute Options in Southern California." *Transportation Research Record 1496* (1995).

Zhou, L., and Winters, P. L., "Empirical Analysis of Compressed Workweek Choices." *Transportation Research Record 2046* (2008).

APPENDIX A—TABLE 19-A—82-PROGRAM SAMPLE

Introduced in the "Analytical Considerations" subsection of the "Overview and Summary," the 82-program sample is drawn upon extensively in this chapter. The introduction to the "Response by Type of TDM Strategy" section further expands upon the use of the 82-program sample in the chapter. This appendix, specifically Table 19-A, provides details on each employer program included. The first column identifies the employer and site for each of the 82 programs. The second column identifies the source of the information, according to the following code:

1. Comsis Corporation. "Task 2 Working Paper: An Examination of Cost/Benefit and Other Decision Factors Used in Design of Employer-Based TDM Programs." TCRP Project B-4. Unpublished research findings and associated data files, Transportation Research Board, Washington, DC (1994).

2. Comsis Corporation and Institute of Transportation Engineers, "Implementing Effective Travel Demand Management Measures: Inventory of Measures and Synthesis of Experience." Prepared for Federal Highway Administration and Federal Transit Administration, Washington, DC (1993).

3. Rutherford, G. S., Badgett, S. I., Ishimaru, J. M., and MacLachlan, S. "Transportation Demand Management: Case Studies of Medium Sized Employers." *Transportation Research Record 1459* (1994).

4. Comsis Corporation, E. N. Schreffler Transportation Consultant, K.T. Analytics, Applied Management and Planning Group, Crain & Associates, David A. Puzo & Associates, and Parsons Brinckerhoff Quade & Douglas, Inc., "MTA TDM Demonstration Program Third-Party Evaluation." Final Report. Prepared for Los Angeles County Metropolitan Transportation Authority (1996).

The "Type," "Location," and "Setting" columns should be largely self-explanatory, with "CBD" standing for Central Business District and "Sub CBD" standing for suburban CBD. It may be inferred that "Campus" and "Office Park" settings are essentially suburban.

The "Near Transit" column gives the transit availability, either "High," "Medium," or "Low." "Transit availability" is a simplified transit accessibility measure where higher transit availability infers service by more scheduled buses/trains on more transit routes. Employers with no nearby transit stop are assigned to the "Low" transit availability ranking. The next five columns describe each employer's TDM program as of the early 1990s, when this data was collected. Program elements are listed according to the four-type TDM categorization used in this chapter, except that parking conditions are identified separately in their own column.

The first two "Vehicle Trip Rate" columns give the project average number of commute round trips per employee for the employer in question ("Project") along with a corresponding baseline average rate against which to gauge the given program's effectiveness ("Control"). For more on the derivation of these baseline rates, see especially Footnote 3 in the "Analytical Considerations" discussion of the "Overview and Summary."

The final "Vehicle Trip Rate" column provides a calculation of the difference between the project vehicle trip rate and the control rate, expressed as a percentage of the control rate ("Difference"). Here the negative values represent an employer program project rate less than the control rate. In contrast, in the tables and text of the main body of this chapter, it is a positive Vehicle Trip Reduction (VTR) rate that implies program success at trip reduction relative to the norm.

Table 19-A Characteristics of 82 Sample Employer and Institutional TDM Programs

Employer/ Location	Source	Type	Location	Setting	Size	Near Transit	Support Measures	Transportation Services	Parking	Incentives	Work Hours	Vehicle Trip Rate: Project	Vehicle Trip Rate: Control	Vehicle Trip Rate: Differ-ence
Aetna (Hartford, CT)	1	Insurance	Hartford, CT	CBD	2,450	High	Rideshare Matching; Transit Info Center and On-site Pass Sales; Preferential Parking; Bike Racks; Guaranteed Ride Home; Promotions	Subsidized Vanpool Program	Limited but Unpriced	Vanpool Subsidy; $21/mo Transit Subsidy (in exchange for parking space)	Flextime	0.77	0.77	0.0%
Allergan (Irvine, CA)	1,2	Manu-facturing	Irvine, CA	Campus	1,425	Low	Vanpool meetings; On-site Services; Transportation Fairs; Bike Racks & Shower Facilities; Preferential Parking;	Vanpool Program; Use of vans for mid-day travel	Plentiful, Free	50% Transit Subsidy; 100% Vanpool Subsidy; Rideshare Days Off; Quarterly Drawings	Flextime; Compressed Work Week; Telecommuting	0.75	0.87	-13.8%
Arlington Hts., IL	1	Local Govt.	Arlington Hts., IL	Sub CBD	250	Low	Rideshare Matching; Guaranteed Ride Home; Bike Racks; Transit Info Center; Promotions; Preferential Parking	None	Adequate, Free	Maximum $500/yr Alternate Mode Subsidy (or time off)	Flextime; Telecommuting	0.80	0.91	-12.1%
AT&T (Pleasanton, CA)	2	Telecom	Pleasonton, CA	Campus	3,980	Low	Relocation Assistance; Rideshare Promotion and Matching; Preferential Parking	None	Restricted but Free	None	Flexible Work Hours (to travel outside peak)	0.81	0.93	-13.4%
AT&T (Silver Spring, MD)	1	Telecom	Silver Spring, MD	Sub CBD	950	High	ETC; Rideshare Matching	None	Restricted, Priced	Transit Subsidies	None	0.57	0.75	-24.0%
Atlantic Richfield (Los Angeles)	2	Petroleum Co.	Los Angeles, CA	CBD	2,000	High	ETC; Rideshare Matching; Guaranteed Ride Home	Subsidized Vanpool Program	Restricted, Priced; SOVs get 1/3 discount, 2-Person CPs get 2/3 discount, HOVs of 3+ Free	Transportation Allowance ($15/mo if use transit or rideshare)	None	0.55	0.84	-34.5%
Baxter Healthcare (Deerfield, IL)	1	Med Inst	Deerfield, IL	Exurban	1,000	Low	Rideshare Matching, Guaranteed Ride Home	None	Adequate, Free	Up to $60/mo Alternate Mode Subsidies	Compressed Work Week; Telecommuting	0.93	0.90	3.3%
Bellevue City Hall, WA	1	Local Govt.	Bellevue, WA	Office Park	650	Med	ETCs; Transit Info Center; On-site Pass Sales; Preferential Parking; Guaranteed Ride Home	Use of City Vehicles for Commuting if 3+ Employees	Restricted, Priced; HOV Discounts	Alternate Mode Subsidies; Annual Pass for Transit or Vanpool	Flextime	0.63	0.90	-30.0%
Boeing Corp (Seattle, WA)	1	Manu-facturing	Seattle, WA	Suburban	85,000	Low	ETCs; Promotions; On-site Pass Sales; Rideshare Matching	Vanpool Program (through provider)	Unrestricted, Free	Alternate Mode Subsidies	None	0.80	0.89	-10.1%
Bonneville Power Adm (Seattle)	3	Elec Utility	Seattle, WA	CBD Fringe	100	Med	Part-time ETC; Computerized On-site Ridematching; Bike Racks & Showers	Vanpools	Tight; $25-$40/mo Parking Charge	$21/mo Transit Subsidy	Flextime; Compressed Work Week	0.58	0.78	-25.6%
Boulder Hosp. (Boulder, CO)	1	Hospital	Boulder, CO	CBD Fringe	1,000	Med	Rideshare Matching; Transit Info Center; Guaranteed Ride Home; Bike Repair Clinics	Shuttle	Adequate, Free	Alternate Mode Subsidies	None	0.67	0.78	-14.1%

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Table 19-A (Continued)

Employer/ Location	Source	Type	Location	Setting	Size	Near Transit	Support Measures	Transportation Services	Parking	Incentives	Work Hours	Vehicle Trip Rate: Project	Vehicle Trip Rate: Control	Vehicle Trip Rate: Difference
Broadway Plaza 1	4	Prof/Office	Los Angeles, CA	CBD	300	High	Comprehensive	None	Restricted, Priced; HOV Discounts	50% Transit Subsidy	None	0.70	0.75	-5.6%
Broadway Plaza 2	4	Prof/Office	Los Angeles, CA	CBD	300	High	Comprehensive	None	Restricted, Priced; HOV Discounts	100% Transit Subsidy	None	0.61	0.73	-15.4%
Brown & Bain, PA (Phoenix)	3	Law Office	Phoenix, AZ	CBD	263	High	Part-time ETC; Computerized On-site Ridematching; Guaranteed Ride Home (taxi reimbursement)	None	Adequate but priced; $25 to $50/mo Parking Charge; 25% Carpool Parking Subsidy	50-75% Transit Subsidy	Flextime; Compressed Work Week	0.82	0.87	-5.7%
California Franchise Tax Board (Sacramento, CA)	1	Non-Profit	Sacramento, CA	Office Park	4,550	Low	Full-time ETC; Rideshare Matching; Transportation Fairs; Transit Info Center & On-site Pass Sales; Dependent Care; Preferential Parking (HOVs of 3+); Bike Racks and Change Facilities; Guaranteed Ride Home	None	Adequate, Free	$50/mo Vanpool Driver Subsidy; $15/mo Transit Subsidy	Staggered Hours (shifts); Compressed Work Week; Telecommuting	0.84	0.89	-5.6%
Cedars Sinai Hosp (Los Angeles)	1	Hospital	Los Angeles, CA	CBD Fringe	6,000	Med	Rideshare Matching; Bike Racks & Lockers; Shower & change Facilities	Shuttle to Metro; Vanpool Program	Restricted and Priced	Parking Cash Out	Telecommuting	0.76	0.87	-12.6%
CH2M Hill (Bellevue, WA)	1,2,3	Eng/Prof	Bellevue, WA	Sub CBD	400	Med	Alternative Mode Info Center; Rideshare Postings; Guaranteed Ride Home; On-site ATM	Company cars for business trips	Restricted, Priced; $56/mo Parking Charge; HOV Discounts	$40/mo Travel Allowance; $15/mo Transit and Carpool Subsidy	Flextime; Compressed Work Week (for all)	0.55	0.90	-38.9%
Chevron (Concord, CA)	2	Petroleum Co.	Concord, CA	Office Park	2,300	Low	Relocation Assistance: Rideshare Matching; Preferential Parking; On-Site Pass Sales; Guaranteed Ride Home; Bike Racks & Shower/Change Facilities	Free Shuttle to Rail Transit; Extensive Vanpool Program	Adequate, Free	Free Shuttle; Some Implicit Vanpool and Transit Pass Subsidy	Flexible Work Hours (to travel outside peak)	0.78	0.90	-13.7%
Childress Buick (Phoenix)	3	Vehicle Sales	Phoenix, AZ	CBD Fringe	101	Med	Part-time ETC; Computerized Ridematching; Guaranteed Ride Home	Company cars available for GRH	On-Street Only	None	Flexible Start Time	0.83	0.87	-4.6%
Chubb Insurance (Warren, NJ)	1	Insurance	Warren, NJ	Office Park	1,300	Low	ETC; Rideshare Matching;Bike Racks; Showers & Changing Facilities; TMA Membership; Dependent Care; Guaranteed Ride Home	Subsidized Vanpool Program & Facility	Adequate, Free	Vanpool Subsidy (internal); Raffles	Flextime; Compressed Work Week; Telecommuting	0.87	0.92	-5.4%
City of La Habra, CA	3	Local Govt.	La Habra, CA	Suburban	123	Low	Part-time ETC; Computerized Ridematching; Guaranteed Ride Home; Bike Racks & Showers; On-site Services	Bike Loan program	Adequate, Free	None	Flextime and Compressed Work Week for Alt. Mode Users Only (50% use); Telecommuting	0.60	0.85	-29.4%
City of Pleasanton, CA	1	Local Govt.	Pleasanton, CA	Office Park	360	Low	ETCs; Rideshare Matching; Guaranteed Ride Home; Bike Racks & Lockers; Promotions; Preferential Parking	None	Adequate, Free	25% Bus & Vanpool Subsidy; $1/day Cash-Out Policy; Raffles	Flextime; Compressed Work Week	0.84	0.89	-5.6%

Table 19-A (Continued)

Employer/ Location	Source	Type	Location	Setting	Size	Near Transit	Support Measures	Transportation Services	Parking	Incentives	Work Hours	Vehicle Trip Rate: Project	Control	Differ-ence
City of Simi Valley, CA	3	Local Govt.	Simi Valley, CA	Suburban	150	Low	Part-time ETC; Regional Computerized Ridematching; Guaranteed Ride Home; Bike Racks & Showers	Fleet Vehicles available for business trips	Adequate, Free	$2-3/day Travel Allowance; Bus Subsidy (additional 50% or $.75/day); Time Off with Pay linked to Alt Mode use; Bike Equipment Allowance	Flextime for Alt Mode Users only; Compressed Work Week (90% use)	0.48	0.85	-43.5%
City Place Mall (Silver Spring, MD)	1	Mall	Silver Spring, MD	Sub CBD	320	High	ETC; On-site Pass Sales	None	Market Only (priced)	Transit Subsidies	Flextime; Staggered Hours (shifts)	0.55	0.75	-26.7%
City/County of Denver, CO	1	Local Govt.	Denver, CO	CBD	12,000	High	Rideshare Matching; Telecommuting and Teleconferencing Training; Bike Racks, Lockers and Maintenance Training; Guaranteed Ride Home	None	Limited and Priced; HOV Parking Discounts	Alternate Mode Subsidies	Compressed Work Week; Telecommuting	0.65	0.81	-19.8%
Commuter Transportation Services (Los Angeles)	3	Non-Profit	Los Angeles, CA	CBD Fringe	117	Med	Part-time ETC; Computerized Ridematching; Guaranteed Ride Home	None	Plentiful but priced; $60/mo Parking Fee	$40/mo Travel Allowance	Flextime; Compressed Work Week (used by 18%); Telecommuting (used by 12%)	0.66	0.80	-17.5%
COMSIS Corp. (Silver Spring, MD)	2	Eng/Prof	Silver Spring, MD	Sub CBD	130	Med	Part Time ETC; Information; On-site Pass Sales	None	Restricted, Priced	$60/mo Transp Allowance (for all employees not receiving parking); Monthly Carpool and Transit Subsidies (County assist)	None	0.66	0.74	-10.5%
Cornell Univ (Ithaca, NY)	1	University	Ithaca, NY	Campus	10,900	Med	ETC; Rideshare Matching; Promotions; Gurараnteed Ride Home; Preferential Parking	None	Restricted, Priced	Alternate Mode Subsidies	Flextime	0.72	0.83	-13.3%
Dean Witter (Riverwoods, IL)	1	Financial Svcs	Riverwoods, IL	Office Park	1,700	Low	ETC; Transit Info Center; Rideshare Matching; Showers & Changing Facilities; TMA Membership; Guaranteed Ride Home	None	Adequate, Free	Alternate Mode Subsidies	Flextime	0.88	0.93	-5.4%
GEICO (Friendship Hts, MD)	1	Insurance	Bethesda, MD	Sub CBD	2,100	High	ETC; Preferential Parking	Vanpool Program; Contract Transit Service	Restricted, Priced	Alternate Mode Subsidies	Flextime; Staggered Work Hours; Compressed Work Week	0.61	0.71	-14.1%
Georgia Power (Atlanta, GA)	1	Elec Utility	Atlanta, GA	CBD	1,800	Med	Transit Info Center; On-site Pass Sales; Rideshare Program; Preferential Parking	None	Limited and Priced (below market rate); HOV Parking Discounts	Transit Subsidy; Prize Points	Flextime (manager approved)	0.91	0.79	15.2%
Gotcha Sportswear (Irvine, CA)	3	Manu-facturing	Irvine, CA	Sub CBD	175	High	Part-time ETC; Personalized Ridematching; Guaranteed Ride Home	None	Plentiful, Free	Time Off with Pay linked to Alt Mode Use rate	Flextime (Alt Mode Users only); Compressed Work Week (used by 18%)	0.60	0.91	-34.1%
G-Street Fabrics (Rockville, MD)	1	Fabric Store	Rockville, MD	Suburban	200	Med	ETC	None	Adequate, Free	Transit Subsidies	None	0.75	0.85	-11.8%

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Table 19-A (Continued)

Employer/ Location	Source	Type	Location	Setting	Size	Near Transit	Support Measures	Transportation Services	Parking	Incentives	Work Hours	Vehicle Trip Rate: Project	Vehicle Trip Rate: Control	Vehicle Trip Rate: Differ-ence
GTE Govt. Systems (Chanitlly, VA)	1	Telecom	Chantilly, VA	Office Park	1,350	Low	ETC; Transportation Newsletter; On-site Services; Preferential Parking; Bike Racks & Showers/Changing Facilities; Guaranteed Ride Home; Heated/Lighted Bus Shelter; Teleconference Center	None	Adequate, Free	Transit Subsidies	Flextime; Compressed Work Week	0.94	0.91	3.3%
Hartford Steam Boiler (CT)	1,2	Insurance	Hartford, CT	CBD	300	High	Carpool Program	None	Restricted and Priced; Carpool Parking Subsidies	50% Transit Subsidy	Flextime	0.49	0.77	-36.4%
Heller Financial Svcs (Glendale, CA)	3	Financial Svcs	Glendale, CA	Sub CBD	253	Med	Part-time ETC; Computerized Ridematching; Guaranteed Ride Home; Bike Racks & Showers	None	Plentiful but priced: $55/mo.	Free parking for Carpools of 3+; Time Off With Pay related to Mode Use	Flexible Start Time for Alternative Mode Users Only	0.76	0.90	-15.6%
Hewlett-Packard (Sacramento)	1	Manu-facturing	Sacramento, CA	Exurban	3,000	Low	ETC; Rideshare Matching; TMA Membership; Promotions; On-site Pass Sales; Preferential Parking; Bike Racks & Showers; Guaranteed Ride Home	On-site bike use	Adequate, Free	None	Flextime; Compressed Work Week; Telecommuting	0.86	0.91	-5.5%
Hillsboro Co. (Tampa, FL)	1	Local Govt.	Tampa, FL	CBD	2,050	Med	ETC & Bike Coordinator; Rideshare Matching; Guaranteed Ride Home; Bike Racks; Pedestrian Enhancements; Vanpool Promotion; TMA Membership	None	Adequate, Free	50% Transit Subsidy	None	0.85	0.88	-3.4%
Hughes Aircraft (Tucson, AZ)	1	Manu-facturing	Tucson, AZ	Exurban	5,000	Low	ETCs; Rideshare Matching; On-site Pass Sales; Bike Racks and Showers; Guaranteed Ride Home; Preferential Parking	Vanpools; Subsidized Bus Service	Plentiful, Free	None	Flextime	0.75	0.87	-13.8%
IT Corp. (Irvine, CA)	3	Eng/Prof	Irvine, CA	Suburban	145	Med	Part-time ETC; Personalized Ridematching; Guaranteed Ride Home; Preferrential HOV Parking	None	Plentiful, Free	100% Bus Subsidy (after 50 trips); $50 pedestrian subsidy (50 trips); annual cash drawing for alt mode users	Flextime; Compressed Work Week (>50% usage)	0.80	0.91	-12.1%
Johnson & Higgins (Seattle)	3	Financial Svcs	Seattle, WA	CBD	182	High	Part-time ETC; Guaranteed Ride Home	Company cars for business trips	Tight; $180/mo Parking Charge	$10/mo Transit Subsidy	Flextime	0.24	0.43	-44.2%
Kinko's Service Corp. (Ventura, CA)	3	Prof/Office	Ventura, CA	Suburban	283	Med	Part-time ETC; Computerized On-site Ridematching; Guaranteed Ride Home; On-site Services; Bike Racks & Showers	None	Plentiful, Free	None	None	0.70	0.85	-17.6%
Kirkland City Hall (WA)	3	Local Govt.	Kirkland, WA	Sub CBD	287	Low	Part-time ETC; Rideshare Postings; Guaranteed Ride Home; Bike Racks & Showers	None	Adequate, Free	$25/month Travel Allowance	Flextime for Alt Mode Users only; Telecommuting	0.77	0.92	-16.3%
K-Mart Valencia (Tucson, AZ)	1	Retail	Tucson, AZ	Suburban	112	Low	Guaranteed Ride Home; Bike Racks & Lockers; Rideshare and Walking Workshops	None	Plentiful, Free	Raffles	Flextime	0.91	0.87	4.6%

Table 19-A (Continued)

Employer/ Location	Source	Type	Location	Setting	Size	Near Transit	Support Measures	Transportation Services	Parking	Incentives	Work Hours	Vehicle Trip Rate: Project	Vehicle Trip Rate: Control	Vehicle Trip Rate: Differ-ence
Lawrence Livermore Labs (Alameda City, CA)	1	Research	Alameda City, CA	Exurban	9,300	Low	ETC; Rideshare Matching; TMA Membership; Promotions; Preferential Parking; Bike Lockers; Guaranteed Ride Home	None	Adequate, Free	$20/mo Transit Subsidy; Purchased Computers for Telecommuters	Telecommuting	0.71	0.86	-17.4%
Master Magnetics (Castle Rock, CO)	1	Manu-facturing	Castle Rock, CO	Exurban	50	Low	Rideshare & Bike Promotion; Bike Racks	None	Plentiful, Free	None	None	0.86	0.93	-7.5%
McClellan AFB (Sacramento,CA)	1	Military	Sacramento, CA	Exurban	12,000	Low	Full-time ETC; Rideshare Matching; Transportation Fairs; On-site Pass Sales; Video Telecom System; Preferential Parking; Bike Racks and Change Facilities	On-site transit shuttle; 65 Electric Vehicles for use on base; Bikes for on-site use	Plentiful, Free	None	Compressed Work Week	0.97	0.89	9.0%
Mercy Home Care (San Diego)	1	Service	San Diego, CA	Office Park	270	Low	Transportation Fairs; Preferential HOV Parking; Guaranteed Ride Home	None	Adequate, Free	Small Gifts & Prizes	None	0.90	0.85	5.9%
National Oceanic & Atmospheric Agency (Silver Spring, MD)	1	Scientific	Silver Spring, MD	Sub CBD	5,000	High	ETC; On-site Pass Sales; Preferential Parking; Guaranteed Ride Home	None	Restricted, Priced	Transit Subsidies	Flextime; Staggered Hours; Compressed Work Week	0.48	0.75	-36.0%
National Optical Observatory (Tucson, AZ)	1	Scientific	Tucson, AZ	Campus	250	Low	Alternate Mode Information; On-site Pass Sales; Rideshare Matching; Showers & Change Facilities	None	Adequate, Free	50% Transit Subsidy	Flextime; Compressed Work Week	0.50	0.83	-39.8%
Nike (Beaverton, OR)	1	Manu-facturing	Beaverton, OR	Campus	2,200	Low	Preferential Parking	None	Limited but Unpriced	50% Transit Subsidy; $1/day to All Others	None	0.83	0.88	-5.7%
Nuclear Reg Comm (Mont. Co., MD)	1,2	Reg. Agency	Rockville, MD	Suburban	1,400	High	ETCs; Rideshare Matching; Preferential Parking; Marketing and Promotion	None	Restricted, Priced	Transit Subsidies	Flextime; Staggered Work Hours; Compressed Work Week	0.59	0.85	-30.6%
P.L.Porter (Woodland Hills, CA)	1	Manu-facturing	Woodland Hills, CA	Campus	230	Low	Rideshare Matching; Transit Information; Preferential Parking; Guaranteed Ride Home	Van Shuttle; Vanpool Assistance Program	Plentiful, Free	$15/mo Transit Subsidy	None	0.67	0.87	-23.0%
Pacific Bell (San Ramon, CA)	2	Telecom	San Ramon, CA	Office Park	6,900	Low	Relocation Assistance; Full Time ETC; Rideshare Matching	Contract Shuttle to Rail Transit; Vanpool Program	Restricted but Free	None	Flexible Hours (to travel outside peak)	0.73	0.93	-21.5%
Pacific Pipeline (Kent, WA)	3	Manu-facturing	Kent, WA	Office Park	138	Low	Part-time ETC; Rideshare Postings; Guaranteed Ride Home; Preferrential HOV Parking	None	Tight but Free	$24/mo. Travel Allowance (if use alt. mode at least 60% of time)	None	0.79	0.93	-15.1%
Pasadena, CA City Hall	1,2	Local Govt.	Pasadena, CA	Sub CBD	2,000	High	Rideshare Matching; Guaranteed Ride Home; Bike Racks & Lockers; Promotions	None	Restricted and Priced; HOV Parking Discounts	Alternate Mode Subsidies	Flextime; Mandatory 9/80 Compressed Work Week	0.66	0.81	-18.5%
Payroll One (Denver)	1	Financial Svcs	Denver, CO	Sub CBD	21	Low	Transit Info Center; Carpool Info; Bike Racks & Changing Facilities; On-site Pass Sales	None	Adequate, Free	None	None	0.80	0.81	-1.2%
Prudential (Jacksonville)	1	Insurance	Jacksonville, FL	CBD Fringe	3,420	Low	Minimal	Vanpool Program	Limited, Free	None	None	0.82	0.87	-5.7%

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Table 19-A (Continued)

Employer/ Location	Source	Type	Location	Setting	Size	Near Transit	Support Measures	Transportation Services	Parking	Incentives	Work Hours	Vehicle Trip Rate		
												Project	Control	Differ-ence
Puget Sound Blood Center (Seattle)	3	Med Inst	Seattle, WA	CBD Fringe	200	High	Part-time ETC; Guaranteed Ride Home	Area employers cooperate to provide additional transit service	Very Tight; $59/mo Parking Charge (7-year wait list);	$25/mo. HOV Parking Discount; 1 day/mo. Free Parking if use Alt Mode; 50% Transit Subsidy	Flextime; Compressed Work Week	0.34	0.59	-42.4%
Rick Engineering (San Diego)	1	Eng/Prof	San Diego, CA	Office Park	120	Low	Preferential HOV Parking; Bike Lockers; Guaranteed Ride Home	None	Adequate, Free	$25/mo Alternate Mode Subsidy	Compressed Work Week	0.77	0.85	-9.4%
Rockbestos (E. Granby, CT)	1	Manu-facturing	Hartford, CT	Exurban	400	Low	Guaranteed Ride Home	Subsidized Vanpool Program	Plentiful, Free	Vanpool Subsidy	None	0.66	0.93	-29.0%
Rosarita Foods (Mesa, AZ)	3	Food Proc	Mesa, AZ	Suburban	229	Low	Part-time ETC; Rideshare Postings; Bike Racks & Showers; Preferrential HOV Parking	None	Adequate, Free	None	Compressed Work Week	0.74	0.91	-18.7%
San Diego Trust & Savings	2	Financial Svcs	San Diego, CA	CBD	500	High	Ridematching	None	Restricted, Priced; Subsidized for SOV and HOV (progressive by occupancy)	$60/mo Transit Subsidy	Flextime (limited)	0.51	0.66	-22.7%
Sears (Hoffman Estates, IL)	1	Service	Hoffman Estates, IL	Exurban	5,400	Low	Rideshare Matching; Dependent Care; Guaranteed Ride Home; Bike Racks & Showers; Preferential Parking	Contract Transit Services; Vanpool Program & Facility	Adequate, Free	Transit Subsidy (through employee to contract transit provider)	Flextime; Compressed Work Week	0.53	0.92	-42.4%
Shure Bros. (Evanston, IL)	1	Manu-facturing	Evanston, IL	Exurban	500	Low	Rideshare Matching (Regional); Promotions; Preferential Parking; Guaranteed Ride Home; Showers & Changing Facilities	None	Adequate, Free	None	None	0.81	0.81	0.0%
Shur-Lok Corp. (Irvine, CA)	3	Manu-facturing	Irvine, CA	Suburb	174	Med	Part-time ETC; Regional Computerized Ridematching; Guaranteed Ride Home; Bike Racks & Showers; On-site Services	None	Plentiful, Free	$21/mo bus pass subsidy; $10-20/mo Carpool Subsidy (linked to use); 50% or $25/wk Vanpool Subsidy; Bike/Walk subsidy (linked to use)	Flextime (Alt Mode Users only)	0.80	0.91	-12.1%
Southern CA Gas (Brea, CA)	1	Nat Gas	Brea, CA	Exurban	1,800	Low	ETCs; Rideshare Matching; Bike Racks and Showers; Guaranteed Ride Home; Preferential Parking	Vanpool Program; Use of Company Vehicles for mid-day travel	Restricted; Parking Fees; HOV Parking Discounts	$50 Commuter Allowance; $60 Transit Subsidy	Flextime; Compressed Work Week	0.41	0.78	-47.4%
State Farm (Orange Co., CA)	2	Insurance	Orange Co, CA	Office Park	980	Low	ETC; Carpool and Vanpool Promotion	None	Adequate, Free	Alternate Users Paid Not to Park as SOV	None	0.64	0.92	-30.4%
Swedish Hosp. (Seattle)	1,2	Hospital	Seattle, WA	CBD Fringe	2,250	High	Guaranteed Ride Home; Construction of Park & Ride Facility	Special Contract Arrangement wih Transit Provider for Express Services	Restricted, Priced; HOV Discounts	Alternate Mode Subsidies (100% transit subsidy)	Flextime (limited); Staggered Work Hours (shifts); Compressed Work Week; Telecommuting	0.51	0.71	-28.2%
3M Corp. (St. Paul, MN)	2	Manu-facturing	St. Paul, MN	Campus	12,700	Low	Broad-Based Alternate Mode Support	Subscription Bus; Vanpool Program	Restricted but Free	Implicit through support of modes	Staggered Hours (shifts)	0.83	0.92	-9.7%

Table 19-A (Continued)

												Vehicle Trip Rate		
Employer/ Location	Source	Type	Location	Setting	Size	Near Transit	Support Measures	Transportation Services	Parking	Incentives	Work Hours	Project	Control	Difference
TransAmerica (Los Angeles)	2	Insurance	Los Angeles, CA	CBD	3,000	High	ETC; Guaranteed Ride Home; Bike Racks and Showers; Preferential Parking	Subsidized Vanpool Program & Facility	Restricted, Priced; Subsidized for All Employees (progressive by occupancy)	$15/mo Transit Subsidy	Flextime	0.56	0.69	-18.8%
Travelers (Hartford, CT)	2	Insurance	Hartford, CT	CBD	10,000	High	Minimal	Subsidized Vanpool Program	Restricted, Priced; HOV Discounts	$15/mo Transit Subsidy; $20/mo Vanpool Subsidy	None	0.43	0.77	-44.2%
UCLA (Los Angeles)	2	University	Los Angeles, CA	Campus	18,000	High	Comprehensive	Vanpool Program (unsubsidized); Operates Several Local Bus Routes, Shuttles, and Park-and-Rides	Tight and Priced, but far below Market Rates;	None	None	0.79	0.84	-5.5%
Univ. of Central Florida (Orlando)	1	University	Orlando, FL	Campus	5,000	Low	Rideshare Matching (local and areawide); Bike Path and Lighted Walkways; Part of Transportation Cooperative	Vanpool Program; Campus Shuttle/ Circulator	Limited but Unpriced	None	Flextime; Compressed Work Week; Telecommuting	0.96	0.86	11.6%
Univ. of Wash (Seattle)	1	University	Seattle, WA	Campus	17,400	High	ETC; Rideshare Matching; Info and Promotions; On-site Pass Sales; Bike Racks, Showers & Changing Facilities; TMA Membership; Preferential Parking; Guaranteed Ride Home	Vanpool Program Facilitation; Reimbursement to Transit Operator for up to 6,000 extra hours of campus service per year	Restricted, Priced; HOV Discounts	Alternate Mode Subsidies (primary focus on UPass Program)	None	0.27	0.71	-62.0%
US WEST (Bellevue, WA)	1,2	Telecom	Bellevue, WA	Sub CBD	1,100	High	ETC; Rideshare Matching; On-site Pass Sales; Guaranteed Ride Home; Preferential Parking	None	Restricted, Priced; HOV Discounts	Transit Subsidy; Bike Equipment Rebates	Flextime; Compressed Work Week; Telecommuting	0.57	0.83	-31.3%
Varian (Palo Alto, CA)	2	Prof/Office	Palo Alto, CA	Campus	3,200	Med	ETC; Bike & Shower Facilities; Rideshare Matching; Promotion; On-site Pass Sales; New Employee Orientation; Commuter Fairs	None	Tight but Free	25% Transit Pass Discount; Award Program	None	0.71	0.86	-17.4%
Ventura Co., CA	2	Local Govt.	Los Angeles, CA	Campus	1,850	Low	Guaranteed Ride Home; Bike/Walk Facilities; Preferential Parking	None	Plentiful, Free	Point Accumulation for not Driving (1 point per day), redeemable for cash at end of year (approx. $100 /yr per average days not driven)	None	0.78	0.90	-13.3%
Walker, Richer & Quinn (Eastlake, WA)	3	Software	Eastlake, WA	Suburban	206	Med	Part-time ETC; Computerized On-site Ridematching	None	Plentiful, Free	100% Transit Subsidy; 60% Vanpool or Ferry Subsidy	None	0.76	0.76	0.0%
Warner Center Hilton (Woodland Hills, CA)	1	Hotel	Woodland Hills, CA	Office Park	165	Low	Preferential Parking; Bike Racks & Showers	None	Adequate, Free	$15/mo Alternate Mode Subsidy	Flextime; Compressed Work Week	0.49	0.87	-43.7%

(continued on next page)

Table 19-A (Continued)

Employer/ Location	Source	Type	Location	Setting	Size	Near Transit	Support Measures	Transportation Services	Parking	Incentives	Work Hours	Vehicle Trip Rate		
												Project	Control	Differ-ence
Wash Adventist Hosp (Takoma Pk., MD)	1	Hospital	Takoma Park, MD	Campus	1,800	Med	ETC; Preferential Parking	None	Restricted but Free	50% Transit Subsidy	Staggered Work Hours (shifts); Compressed Work Week	0.80	0.71	12.7%
Wm. H. Mercer (Seattle)	3	Financial Svcs	Seattle, WA	CBD	120	High	Part-time ETC; Guaranteed Ride Home; Preferential HOV Parking	Company cars for business trips	Adequate but Priced: $130/mo Parking Charge; $39/mo HOV Parking Discount	100% Bus & Ferry Subsidy	Flextime	0.34	0.44	-22.7%

Sources: Comsis (1994), Comsis and ITE (1993), Rutherford et al. (1994), and Comsis et al. (1996).

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Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation