

Traveler Response to Transportation System Changes

New Insights from the Revised Handbook

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How do changes in the transportation system affect travel demand? This information is essential in planning and evaluating transportation facilities and services as well as in structuring operations and determining policy. Since 1977, the U.S. Department of Transportation's handbook, *Traveler Response to Transportation System Changes*, has served as a valuable reference for transportation planners and decision makers.

The most recent version of the handbook, however, dates back to July 1981. Substantial changes and advances have occurred in the field in the two decades since. Therefore the Transit Cooperative Research Program (TCRP) has undertaken an update and expansion of the handbook. Until release of the completed third edition, TCRP has published an *Interim Handbook* electronically on the web,¹ to facilitate applications of the information.

Handbook's Scope

The *Traveler Response* handbook provides comprehensive, interpretive documentation of how various types of transportation system changes affect travel demand and the use of transportation facilities and services. The handbook addresses transportation system changes ranging from the introduction of new facilities—for example, a high-occupancy vehicle (HOV) lane; to modifications in service, fares, or prices; to different approaches—such as mixed versus monolithic land use. The document is as much a sourcebook as a step-by-step handbook.

The third edition of the handbook will cover 17 topic areas of system change (Table 1)—all the topics in the 1981 edition, with slight modifications in scope, plus a roughly equal number of new topics. The *Interim Handbook* contains the seven topics now complete and ready for use.

Each chapter offers specific guidance, categorizes the transportation system changes to be addressed, synthesizes reported traveler responses to each type of change, presents underlying travel-demand factors, and provides special subtopics, case studies, and references. The syntheses of traveler responses are the core of each chapter. Special subtopics may include information on user characteristics, time required to establish use, environmental factors, cost and revenue outcomes; and other relevant subjects.

Analytical Focus

The *Traveler Response to Transportation System Changes* handbook expresses travel demand and related impacts through such measures as numbers of riders and vehicles using transportation facilities and services, before-and-after market shares and percentage changes, numerical relationships such as elasticities,² and simple indicators of feasibility. The findings derive primarily from reported results and analyses of real-world applications and experiments with transportation facilities, services, and policies. Results from travel demand model estimates and similar research augment the data to fill gaps and provide additional insights.

¹TCRP Web Document 12, available in portable document format (PDF): <http://www4.nationalacademies.org/trb/crp.nsf/All+Projects/TCRP+B-12>

²The handbook's introduction includes a section on the concept of elasticity, and an appendix provides derivation and application formulae.

TABLE 1 *Traveler Response to Transportation System Changes:*
Third Edition Topics

	Interim Handbook	Carryover Topic	Added Topic
General Sections and Topic Areas			
Ch. 1 – Introduction	X		
Multimodal/Intermodal Facilities			
Ch. 2 – HOV Facilities	X		
Ch. 3 – Park and Ride/Park and Pool		X	
Transit Facilities and Services			
Ch. 4 – Busways and Express Bus		X	
Ch. 5 – Vanpools and Buspools	X		
Ch. 6 – Demand Responsive/ADA	X		
Ch. 7 – Light Rail Transit			X
Ch. 8 – Commuter Rail			X
Public Transit Operations			
Ch. 9 – Transit Scheduling and Frequency	X		
Ch. 10 – Bus Routing and Coverage	X		
Ch. 11 – Transit Information and Promotion		X	
Transportation Pricing			
Ch. 12 – Transit Pricing and Fares	X		
Ch. 13 – Parking Pricing and Fees	X		
Ch. 14 – Road Value Pricing			X
Land Use and Nonmotorized Travel			
Ch. 15 – Land Use and Site Design		X	
Ch. 16 – Pedestrian and Bicycle Facilities			X
Transportation Demand Management			
Ch. 17 – Parking Management and Supply		X	
Ch. 18 – Transportation Demand Strategies			X

The handbook updating and expansion was not intended to require original research. The process has involved the synthesis, distillation, and interpretation of reports, papers, and research by others. Nevertheless, to fill major gaps, the research team has performed original assessments of key undertakings, relying on cooperative operating and planning agency staff to assemble significant data and analyses.

Handbook Use

On the basis of the first two editions and early feedback on the *Interim Handbook*, the new volume should attract interest from transit and transportation planners, researchers, and educators across the spectrum of operating agencies; metropolitan planning organizations; local, state, and federal gov-

ernment agencies; consultants; and educational institutions. The handbook will provide valuable information such as

- ◆ Promising approaches for achieving transportation goals;
- ◆ Feasibility indicators to screen proposals;
- ◆ Insights into project successes and failures;
- ◆ Real-world data for checking outputs from models of demand;
- ◆ Empirical findings for reference when modeling is impractical;
- ◆ Responses and impacts sorted by subgroups and sectors;
- ◆ Data on use and user characteristics; and
- ◆ Secondary effects and other nuances of outcomes from applications.

The handbook is intended as a starting point, not an exhaustive resource for issues that require geographic and modeling analyses. The evaluation of transportation options must consider the particular urban form, population, travel patterns, and transportation systems involved. Through case studies, identification of additional resources, and reference lists, the *Traveler Response* handbook points the reader to more detailed research and texts.

Examples of findings and possible applications based on the *Interim Handbook* illustrate uses of the publication.

Handbook Examples

HOV Facilities

The HOV facilities chapter tabulates the use of HOV lanes by vehicles and persons. The data indicate that active Interstate highway HOV lanes open to both carpools and buses carry morning peak-hour volumes of 1,500 to more than 11,000 persons per hour. Average vehicle occupancy on facilities open to carpools ranges from 1.90 to 8.16—including buses and illegal users. Reported time savings for carpool users range from 2 to 39 minutes, and the travel time reliability is clearly an attraction to users.

A strong relationship is evident between the volume of bus vehicles on an HOV facility and the volume of total persons carried. Direct causality explains the correlation only partially; it is likely that the feasibility of bus service and the total HOV facility use are both related to the nature of travel in the corridor.

The average HOV facility carries 40 percent of its person volume on buses; the corridor travel patterns and parameters that support transit use also enhance the attractiveness of carpooling. Figure 1

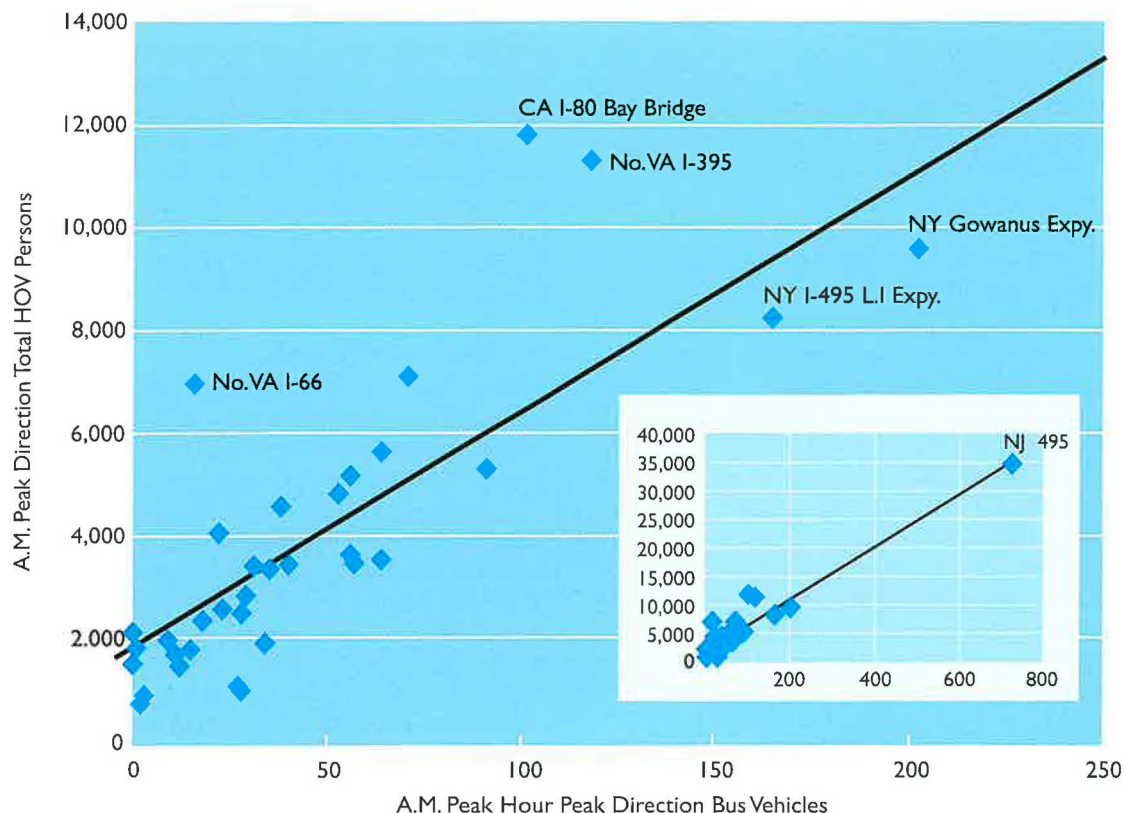


FIGURE 1 Total person volumes related to bus vehicle volumes at peak hour in peak direction for 35 HOV facilities. (Person volumes include bus passengers plus carpool and vanpool occupants.)

illustrates the relationship between bus vehicle volumes and total persons carried on the HOV facility.

A user of the *Traveler Response to Transportation System Changes* handbook therefore should question the viability of an HOV facility proposal if a corridor cannot support express bus service. According to the handbook, the possibility that a considerable volume of buses—25 to 30 buses or more in the peak hour—may use the facility indicates likely success. Correspondingly, a handbook user advocating design accommodations for buses on an HOV facility would find many supportive examples of the importance of bus riders to facility use—but also enough exceptions to maintain a level of caution.

Vanpools and Buspools

The subsection on the extent of vanpooling and buspooling in the chapter on vanpools and buspools reveals that vanpooling has been in the doldrums since the fuel crises of the 1970s and particularly since the relaxation of mandatory employer commute provisions in the Clean Air Act of 1990. However, vanpool offerings by transit operators have increased. In 1997, the top five transit operator fleets ran a total of 1,497 vanpools, up by a factor of six in eight years. The trip length for

transit operator vanpool riders in the mid-1990s averaged 32.4 miles, compared with the 4.9-mile average length of an unlinked transit trip.

In a case study of Connecticut's Easy Street® vanpool program, the handbook chapter also presents a series of innovations that have turned around declining trends in vanpool ridership in central and eastern Connecticut. Actions range from a decal design displaying the phone number on all vans to supplementing traditional monthly fares with part-time and daily fare options.

Another case study, of the Pace vanpool and subscription bus programs in suburban Chicago, describes the ADvAntage vanpools for individuals with disabilities—an alternative to conventional Americans with Disabilities Act (ADA) transit service.

Demand Responsive/ADA

The chapter, "Demand Responsive/ADA," reports annual rides per capita rates for a half-dozen urban, areawide, general public, 5-to-7-days-a-week demand responsive systems. Use ranges from 0.5 to 6 or 7 annual rides per capita, with a median value of 3. Although there are no data for ridership attracted using computer-assisted real-time re-

sponse to service requests, the top performer achieves real-time dispatching via radio.

A transit agency staff member facing a board concerned that a new demand responsive service would never grow beyond its initial ridership would find a graphic from the *Interim Handbook* helpful (Figure 2). According to the graph, the first three routes of a point deviation system in Prince William County, Virginia, carried about 25 percent as much ridership in the first month as in the twelfth month. The full third edition of the handbook will show that ridership on new rail rapid transit and commuter rail lines has followed a similar trend.

Nonetheless, the handbook warns the analyst about high variability in the ridership development rates of individual transit services. In addition, information in the HOV facilities chapter shows that growth in multimodal system use can be slower. On HOV facilities, carpool and bus users not only must find out about—and accommodate to—the new options; the bus users also may have to wait out institutional delays in providing services, such as the establishment of bus routes using the new facilities.

Transit Scheduling and Frequency

The “Transit Scheduling and Frequency” chapter reports new data confirming the finding in the *Traveler Response to Transportation System Changes* handbook that the average response to frequency changes, including increases and decreases, approximates a service elasticity of +0.5.³ However,

case studies in this chapter and in the “Bus Routing and Coverage” chapter show that in supportive environments, ridership response may be double this rate, avoiding loss in service productivity.

Typical supportive environments appear to be suburban areas with growth economies and a good transit image, where service frequencies have been relatively low. Obviously the converse also occurs; the handbook gives examples of little or no ridership response.

Bus Routing and Coverage

Results for a smorgasbord of individual and systemwide bus routing changes and new service introductions—including routes connecting disadvantaged neighborhoods with jobs—appear in the “Bus Routing and Coverage” chapter. The mid-range of ridership response to expansions of bus transit is bounded by service elasticities of +0.6 to +1.0, with broader variations also reported. Among conventional bus routes, those serving multiple markets fare best.

When services have achieved operating efficiencies and ridership growth in tandem, restructuring reflects most of the following characteristics:

³A service elasticity of +0.5 indicates a 0.5 percent increase in ridership in response to each 1 percent service increase (or a 0.5 percent ridership decrease in response to each 1 percent service decrease), calculated in infinitesimally small increments.

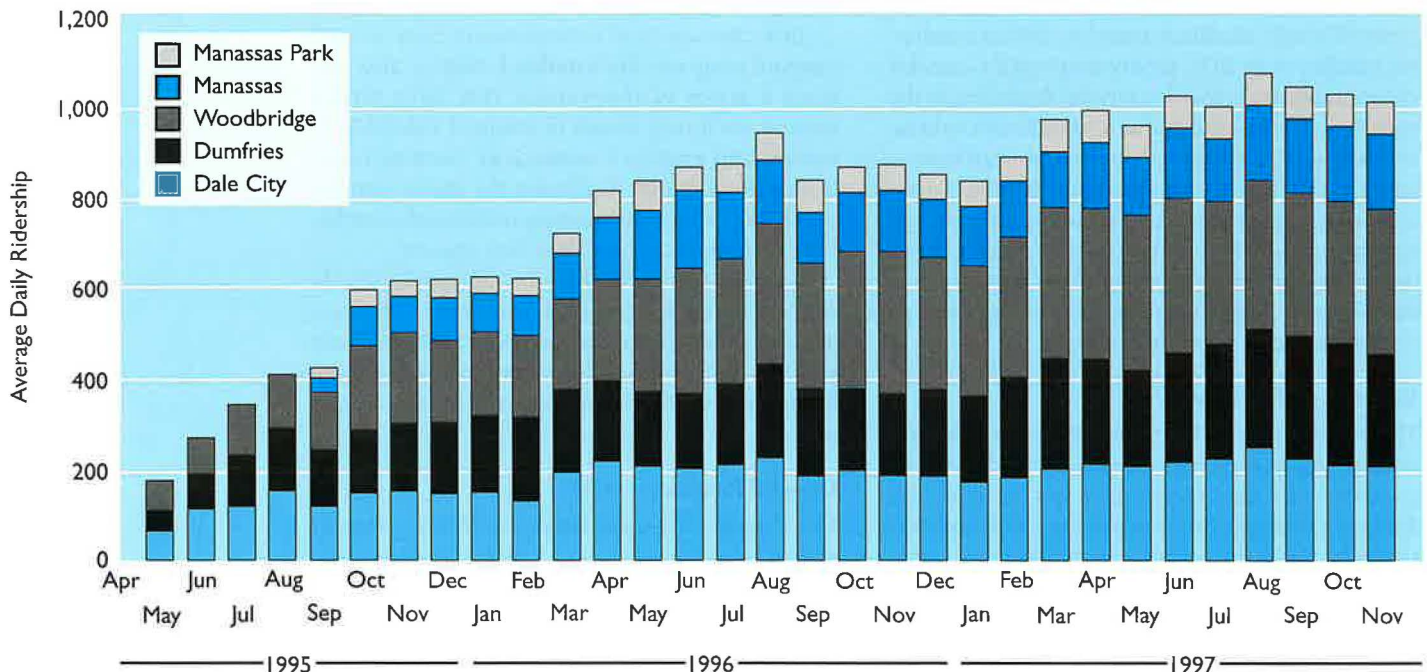


FIGURE 2 Ridership growth in OmniLink point deviation service, Prince William County, Virginia.

- ◆ Emphasis on developing core routes with high service levels,
- ◆ Consistency in scheduling,
- ◆ Enhancement of direct travel and ease of transferring,
- ◆ Design based on quantitative investigation of travel patterns, and
- ◆ Favorable economic conditions.

Downtown shuttle bus systems are the most problematic type of service to introduce; experience shows only mixed success. The systems have proved more successful when a transportation need or opportunity is identifiable, the service is well targeted, and distances discourage walking. It is difficult to attract lunchtime travel unless the intervals between buses are 10 minutes or less—2- to 6-minute service intervals work best if the market and the funding can provide the support.

Recent surveys in nine cities suggest that riders' purposes for using bus services vary by city size. Travelers to or from work make up 26 to 42 percent of the ridership in the three service areas under 400,000 in population, 38 to 50 percent in service areas of 400,000 to 1 million people, and 53 to 58 percent in the three areas of more than 1 million residents.

Table 2 consolidates the modes that riders report they would use if there were no bus service. The degree of anticipated trip suppression—riders who report they would “not make [the] trip”—is in line with or slightly lower than figures recorded during systemwide transit strikes.

The user of the handbook who follows the cross-referencing among the chapters will gain the most information. One of the more promising developments in conventional transit service is the unlimited travel pass partnership, described from different perspectives in the “Bus Routing and Coverage” chapter and in the “Transit Pricing and Fares” chapter.

Transit operators partner with employers, universities, or other institutions, which prepay for unlimited travel passes; the employer or institution may collect periodic user fees from employees or students or may provide the passes free of charge. In the case of universities, when service expansion has been part of the agreement, ridership increases have been as high as threefold, with significant mitigation of university traffic and of the demand for parking.

Transit Pricing and Fares

The chapter on transit pricing and fares concludes that the aggregate response of bus transit riders to conventional fare increases hasn't changed in more than one-third of a century. A benchmark study published in 1991 (2) produced an aggregate bus

TABLE 2 Alternative Travel Modes Chosen by Bus Riders in Nine Cities (1)

Alternative Mode if Bus Not Available	Percent Choosing
Car	8–32%
Walk	13–24
Ride with someone	16–28
Taxi	4–16
Bicycle	2–7
Not make trip	14–25
Multiple answers	0–13

transit fare elasticity of -0.40 .⁴ But concluding from this result that transit users today react more severely to fare changes misunderstands the seminal 1960s investigations by Simpson and Curtin (3) and the subsequent applications of their findings.

The so-called Simpson and Curtin rule that the percentage loss in ridership averages one-third of the percentage increase in fare is not a fare elasticity but a shrinkage factor; moreover, the rule as stated does not accurately represent the original formula. When the Simpson and Curtin formula is converted to arc elasticity—which has become the preferred way of relating the original and final values of demand and price—it produces values in the -0.39 to -0.41 range, virtually the same as the 1991 results. Other data over the years also are reasonably consistent with a -0.40 average elasticity for bus transit fares.

The handbook offers a complete exposition of the Simpson and Curtin formula, explains the limitations of the corresponding traditional rule of thumb, and then offers more up-to-date data. Even though the aggregate response to bus transit fare changes may be stable, the outcomes and the fare elasticities vary widely. Riders are more sensitive to fare changes (i.e., the elasticities are higher) in small cities and suburbs, in off-peak hours, and

⁴A negative elasticity for fares or parking prices indicates that the effect operates in the opposite direction from the cause. A fare elasticity of -0.4 indicates a 0.4 percent decrease in ridership in response to each 1 percent increase in fare (or a 0.4 percent ridership increase in response to each 1 percent fare decrease), calculated in infinitesimally small increments. Fare elasticities are almost always negative—when the fare goes up, patronage normally goes down, and vice versa.

where service is marginal. Riders are less sensitive to fare changes in large cities, in peak hours, and on rail rapid transit.

A highly provocative finding, not yet fully developed because of scarce data, is that some electronic fare applications accompanied by simplified fare payment appear to attract more new riders than can be explained by the fare savings alone.

Parking Pricing and Fees

Parking demand elasticities with respect to price generally range from -0.1 to -0.6 . Although -0.3 is the most frequently cited value for average elasticity, it is high for employee parking. One analysis of seven case studies produced a low average elasticity (-0.15) but also showed a sizable difference between cars driven per employee with and without employer-paid parking—72 versus 53 cars per 100 employees. The handbook points out that price elasticity can be a deceptive gauge unless applied to a particular price differential or price change.

A case study, "Contrasting Approaches to Parking Pricing in Downtown Los Angeles," provides insights on mode shifts that may result from changes in parking prices. Two employers used the same parking facility at \$100 per month; one company offered 24 percent of its employees subsidized parking at \$60 per month, the other gave 59 percent of its employees subsidized parking on a sliding scale from \$50 per month for single-occupant vehicles to free parking for carpools of three or more.

The first approach imposed a stronger restriction on parking supply, and only 49 percent of the employees drove alone, while 20 percent took carpools or vanpools, and 31 percent used transit. The other approach cost the employer more than four times as much and included promoting alternative modes and providing a travel allowance for vanpoolers; yet the policy produced a nearly identical rate of 48 percent single-occupant drivers, with 34 percent in pools, and only 18 percent using transit. According to the authors of the original study (4), simple elimination of parking subsidies is the more cost-effective strategy for vehicle trip reduction; but perhaps the case study only pertains if transit service is good.

Call for Comments

These examples provide glimpses into the data, discussions, applications, and resources in the *Traveler Response to Transportation System Changes* handbook. For more extended study, visit the TCRP *Interim Handbook* website.

The third edition is still in progress; the study team welcomes comments and new findings—particularly late-breaking and hard-to-come-by information on any of the topic areas listed in Table 1. Contact Dick Pratt at 301-933-0400, fax 301-933-0608, or e-mail rhpratt@his.com.

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