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ANALYSIS OF INDIRECT SOURCE TRIP ACTIVITY:

Regional Shopping Centers

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

AIR RESOURCES BOARD
Research Division

ANALYSIS OF INDIRECT SOURCE TRIP ACTIVITY: Regional Shopping Centers

Final Report

Contract No. A132-094

Prepared for:

California Air Resources Board
Research Division
2020 L Street
Sacramento, California 95814

Prepared by:

JHK & Associates
2000 Powell Street, Suite 1090
Emeryville, CA 94608

and

K.T. Analytics, Inc.
Phase III Market Research
Transportation Management Services

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Acknowledgments

California Air Resources Board
Fereidun Feizollahi
Terry Parker

International Council of Shopping Centers
Doug Wiele

Case Study Sites
Shopping Center Management

JHK & Associates
Deborah A. Dagang, Project Manager
William R. Loudon, Responsible Officer
Shelby A. Tedesco, Transportation Engineer
Christienne L. Rodgers, Technician
Monica Y. Fielden, Clerical
Lillian M. Moore, Clerical
Christopher Liebbe, Clerical
Marsha A. Isley, Graphics

K.T. Analytics, Inc.
Thomas Higgins
Mona Sur

Phase III Market Research
Nancy Pitta
Clara Marie de Gammara

Transportation Management Services
Peter Valk
Stuart Anderson

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ABSTRACT

This research project was undertaken to provide a better understanding of the travel characteristics for regional shopping centers, one category of indirect sources, and to develop a methodology for evaluating travel reduction measures at regional shopping centers. To attain the study objectives, a number of tasks were identified, including a review of the literature related to shopping centers and travel reduction measures, the development of a database of shopper survey responses, the application of the analytical methodology to five regional shopping centers that served as case study sites, and the identification of recommended areas for future research.

Two significant research findings emerge from the data collected for this study and from the application of the methodology to the five case study sites.

1. A significant portion of the variation found in travel mode to regional shopping centers can be explained by the amount and regional coverage of public transit service and the density and proximity of the surrounding land uses. Differences in the demographic and trip characteristics of travelers to each of the case study sites do not appear to explain the variation in travel mode.

2. For the case study sites, the estimated impact of the individual travel reduction measures on the number of trips to the regional shopping center ranges from 0.1 percent to 6.2 percent. This does not include the measure parking pricing (10.5 percent), which, if implemented only at regional shopping centers, may have a negative impact economic impact as a result of travel shifting to other locations. In combination, packages of travel reduction measures might (without parking pricing) reduce trips by five to seven percent.

The results from this research project provide guidance to regional air districts and local governments in the evaluation of travel reduction measures at regional shopping centers, and provide a significant addition to the research and literature on travel to regional shopping centers.

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1.0 SUMMARY AND CONCLUSIONS

One goal of the California Air Resources Board (ARB) is to reduce vehicular emissions and take actions that reduce tailpipe emissions. To comply with the requirements of the California Clean Air Act (CCAA), vehicle trips and vehicle miles of travel (VMT) also must be reduced. Local air districts in nonattainment areas throughout the state are required to develop air quality plans that reduce vehicle trips and VMT, and these plans focus on both commute and non-commute trips. Indirect source controls are one method of impacting non-commute travel. This project was undertaken to provide a better understanding of the travel characteristics for regional shopping centers, one category of indirect sources, and to develop a methodology for evaluating travel reduction measures at regional shopping centers.

Five regional shopping centers located in metropolitan urban areas throughout California were identified as case study sites. To protect confidentiality, the name of each regional shopping center will not be revealed in this report. Each center was assigned an acronym that generally describes its characteristics. These acronyms are listed below.

- SL1: first suburban location with low surrounding land use densities and transit service.
- SL2: second suburban location with low surrounding land use densities and transit service.
- SM: suburban location with medium surrounding land use densities and transit service.
- SH: suburban location with high surrounding land use densities and transit service.
- UH: urban location with high surrounding land use densities and transit service.

An Advisory Committee was formed to assist in the project. The Advisory Committee helped gain the cooperation of the regional shopping centers participating in the study, identified key issues, critiqued interim results, and generally helped ensure valid and useful results. One member of the Advisory Committee in particular, the International Council of Shopping Centers, provided input during the study and helped develop implementable results. Other agencies that participated in the Advisory Committee were Caltrans, various air districts, ARB staff, and various metropolitan planning organizations (MPOs). A full listing of Advisory Committee members is provided in Appendix A.

#1. Explanation of Variation in Travel Mode

The variation in travel mode (e.g., auto, transit, bicycle, walk) is best explained by the amount and regional coverage of public transit service and the density and proximity of the surrounding land uses. While there were differences in the demographic and trip characteristics of travelers to each of the case study sites, the mode shares tend to be consistent across the case study sites within individual demographic or trip characteristic categories, such as age range or trip purpose. In short, center characteristics largely determine mode share.

Evidence for this conclusion comes from an examination of the percentage of travel by mode at the case study sites and possible reasons for variation in the mode shares. As indicated in Table 1-1, there are noticeable differences in the distribution of travel mode across the case study sites. SL1 has by far the highest auto use (95.0 percent), although much of this is in vehicles with two or more people. UH has the highest use of transit and walking (roughly sixty percent combined) with the lowest drive-alone percentage. Only about one-third of those traveling to UH arrive by auto. Both SM and SH have a high percentage of persons walking, about one out of five. The highest drive-alone percentage occurs at SL2, which also has the second lowest percentage of transit use and walking. There was little, if any, bicycle use at the case study sites.

The percentage of travel by mode described above were compared to the data collected at each of the case study sites, including site characteristics and responses to the shopper survey, to determine possible explanations for the mode share differences. Possible explanations included differences in demographic characteristics of shoppers among the regional shopping centers, differences in the travel patterns or trip purposes of the shoppers, and the site characteristics of the shopping center itself. Based on the comparison performed, there appears to be a direct correlation between the amount and coverage of transit services and the amount of transit use, which is not influenced by the variation in demographic characteristics of the shoppers, as illustrated in Figure 1-1. In particular, those sites with higher levels of transit service (UH, SH) have a significantly higher transit mode share. The results hold consistently across age, income, and gender groups. Walk mode share can be explained in a similar fashion. As illustrated in Figure 1-2, those sites that have higher densities of surrounding land uses, and concurrently, more mixed-use development, have greater walk shares.

While many of the findings of this study are specific to the case studies examined, there are a number of implications for future applications of travel reduction measures and development of regional shopping centers. These implications are listed below.

Transit

- Regional shopping centers are likely to have a significantly higher percentage of trips made to and from the center by transit if located where there is direct service from a regional transit system.
- Small changes in bus service will generally not have a large impact on transit use.
- Whenever possible, bus stops should be located near building entrances.

Bicycling/Walking

- Locate regional shopping centers near dense, mixed land uses.
- Reduce impedances to bicycling and walking.

Parking

- While parking pricing may be an effective travel reduction measure, it should not be implemented solely at regional shopping centers due to its potential to divert shoppers to other shopping locations.
- Low pricing levels may not have much of an impact on travel mode, especially if many merchants offer validation.

Center Development/Redevelopment

- Locate in proximity to regional transit system and dense, mixed land uses.
- Locate the building entrances near sidewalks and pedestrian access.

This study has provided a significant addition to the research and literature on travel to regional shopping centers and indirect sources. In addition, a basis for conducting future research has been provided.

1.1 KEY FINDINGS OF THE STUDY

Two significant research findings emerge from the data collected for this study and from the application of the methodology to the five case study sites. These findings, along with some supporting, secondary findings, are described in the following sections.

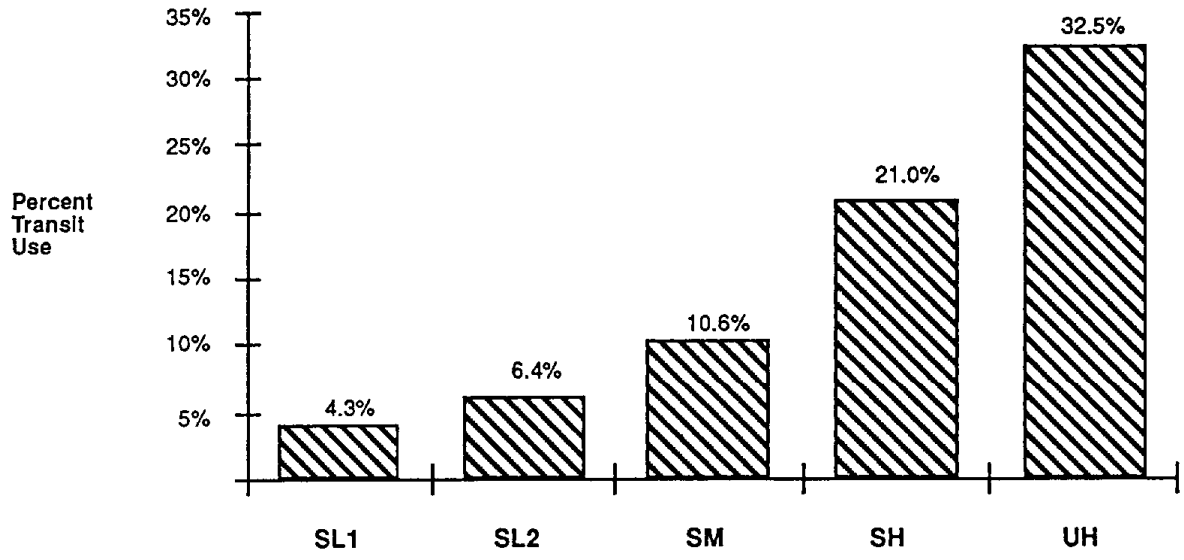

Figure 1-1
Transit Mode Share: Case Study Sites

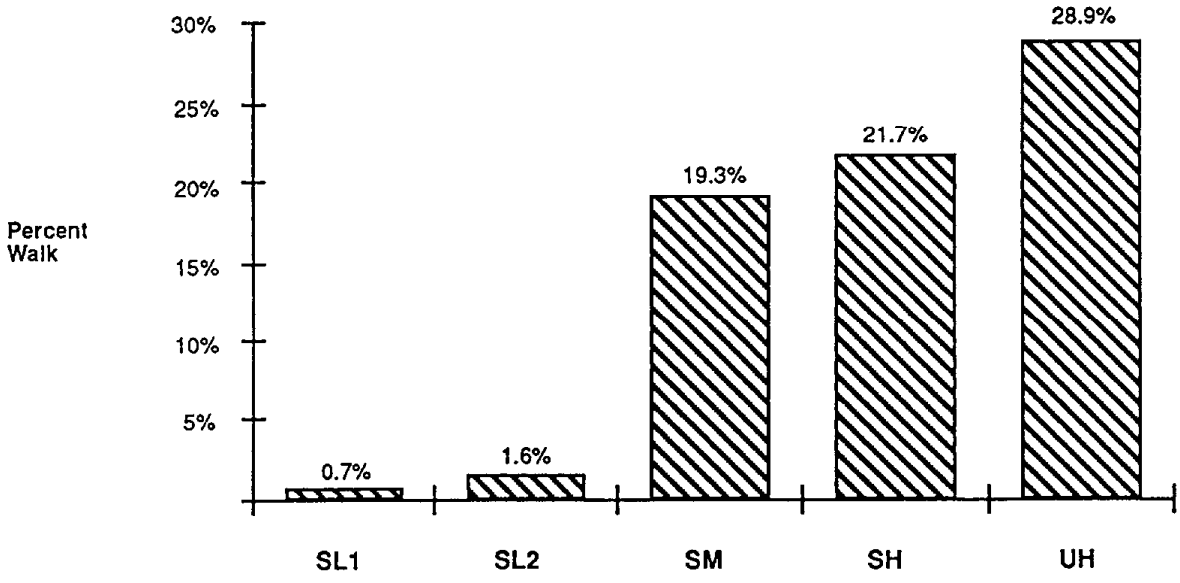

Figure 1-2
Walk Mode Share: Case Study Sites

Table 1-1
MODE SHARE BY CASE STUDY

	SL1	SL2	SM	SH	UH
Percent of all trips that are:					
Auto	95.0	91.0	69.1	57.3	38.3
Drive alone	*18.3*	*46.2*	*36.2*	*26.0*	*16.2*
2 people	*39.0*	*33.3*	*24.9*	*22.0*	*14.3*
3+ people	*37.7*	*11.5*	*8.0*	*9.3*	*7.8*
Transit	4.3	6.4	10.6	21.0	32.5
Bicycle	0.0	1.0	1.0	0.0	0.3
Walk	0.7	1.6	19.3	21.7	28.9
Total	100.0	100.0	100.0	100.0	100.0

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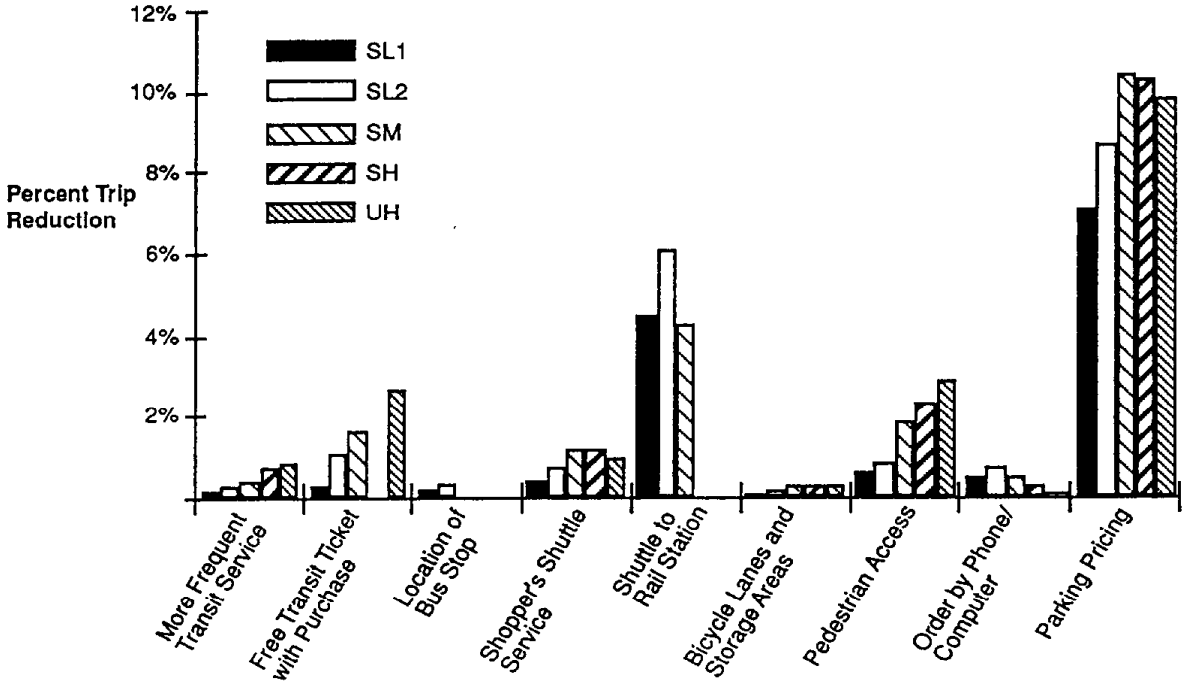

Figure 1-3
Analysis Results

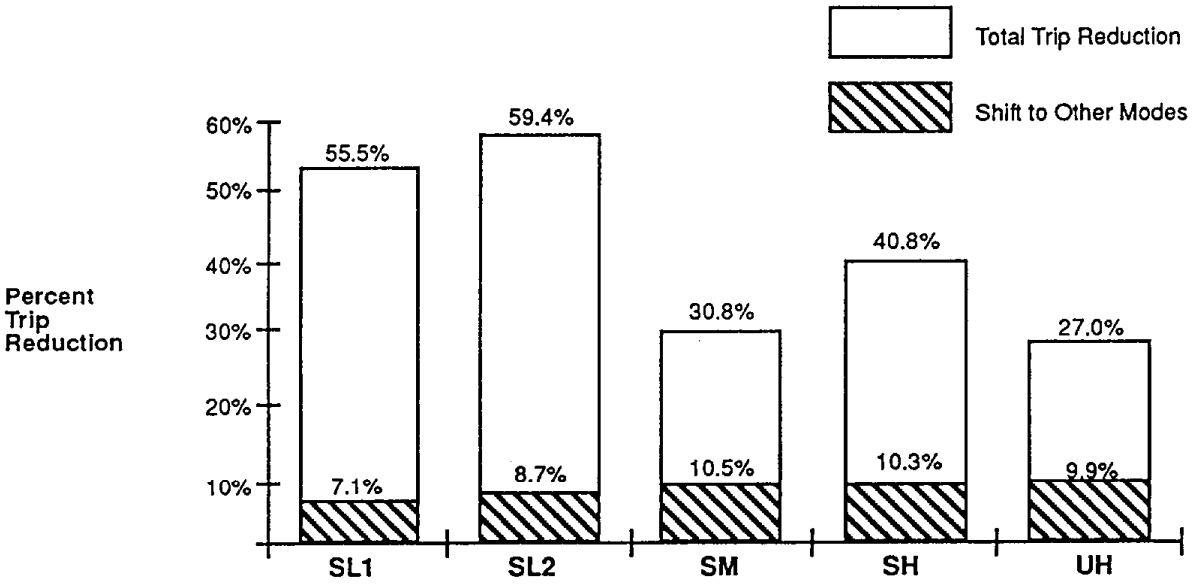

Figure 1-4
Impact of Parking Pricing

#2. Estimated Impact of Travel Reduction Measures

A set of equations was developed in this study to predict the effect of travel reduction measures. For the case study sites, the estimated impact of the individual travel reduction measures ranges from 0.1 percent to 10.5 percent, or 6.2 percent if parking pricing is not included. A summary of the analysis results is provided in Figure 1-3. As is indicated in the figure, the most effective travel reduction measure appears to be the implementation of parking pricing. The values reflected in Figure 1-3, however, are only the trips that are reduced as a result of individuals shifting to other modes. As illustrated in Figure 1-4, there are many additional individuals who would be likely to shop at another site, assuming that other sites did not charge for parking. Parking pricing implemented only at regional shopping centers, therefore, would significantly shift trip destinations in addition to mode of travel. In addition, changing the destination of the trip may increase the trip length or even create multiple trips to individual stores rather than one shopping center. Either of these scenarios would actually produce more vehicular emissions. In addition, the regional shopping center that implements parking pricing may experience a negative economic impact.

Some observations regarding the remaining travel reduction measures are provided below.

- The estimated increase in use of alternative modes is greater at regional shopping centers as the existing use of that mode increases.
- After parking pricing, the second most effective measure appears to be the provision of a shuttle to a nearby rail station. (This measure was not evaluated for SH, which does not have rail service in the area, or UH, which has a rail station within walking distance.)
- Improved pedestrian access was estimated to be as effective at reducing trips as the provision of a free transit ticket with a purchase (which is already offered at SH).
- Locating bus stops closer to building entrances was only evaluated for the two case study sites that do not already have bus stops located near the building entrances. This measure appears to have a relatively low impact, but this is as likely due to the infrequent transit service as the impact of the bus stop location.
- There was a relatively low impact from ordering by telephone or computer (rather than making a trip to the shopping center). This is due in part to the low proportion of trips made solely to purchase items, with no secondary purpose.

- Task 7. Conduct a Workshop Presenting Research Results
- Task 8. Prepare a Final Report

The Advisory Committee reviewed the progress of the study at key points, assisted in the selection of the case study sites and reviewed the analytical approach.

For this research project, twelve travel reduction measures were identified as potentially applicable to regional shopping centers. The measures are listed below and described in more detail in Chapter 5 of this report.

- More Frequent Transit Service
- Free Transit Ticket with Purchase
- Location of Bus Stop Closer to Building Entrance
- Shuttle to Rail Station
- Shopper's Shuttle to Nearby Residences and Businesses
- Reserved Parking for 3+ Carpools
- Bicycle Lanes and Lockers
- Safe and Convenient Pedestrian Walkways
- Reduced Walking Distance from Sidewalk to Buildings
- Free Home Delivery of Purchased Items
- Ordering by Phone
- Ordering by Computer

Data used for analyzing the travel reduction measures and travel behavior to regional shopping centers included information collected from the case study sites and from an extensive literature review.

Regional Shopping Center Case Study Sites

Three of the five regional shopping centers were located in Northern California and two in Southern California. The case study sites were selected to represent a variety of land use and transportation service characteristics that might impact travel behavior to a regional shopping center. They were not, however, selected to be a statistically representative sample of regional shopping centers in California. For this reason, the data for each case study site were evaluated individually, and there was no analysis performed on a combined data set. Case study data were collected primarily through on-site interviews with shopping center management. A summary of the characteristics of each case study site is provided in Table 1-2.

While it would not be accurate to sum the trip reduction estimates of individual measures, a combined impact was estimated for those measures that do not compete or conflict with one another. Examples of non-competing/non-conflicting measures include providing a shuttle to a rail station and providing pedestrian access. A package of travel reduction measures at a regional shopping center, not including parking pricing, might reduce trips by five to seven percent.

1.2 OBJECTIVES OF THE PROJECT

In arriving at the key findings addressed above, a number of specific objectives guided this research project. The primary objectives were to:

- develop an understanding of characteristics of travel (non-work related) to regional shopping centers;
- evaluate the features of regional shopping centers that impact travel behavior;
- develop a methodology to evaluate the impact of travel reduction measures at regional shopping centers;
- develop an agenda for future research on travel behavior and trip reduction at shopping centers.

A number of tasks were identified to meet these objectives. These tasks included a review of the literature related to shopping centers and travel reduction measures, the development of a database of shopper survey responses, the application of the analytical methodology to information gathered from five regional shopping centers that served as case study sites, and the identification of areas recommended for future research.

1.3 HOW THE WORK WAS PERFORMED

The consultant team performed this study according to eight tasks defined by ARB. These tasks are listed below and described in more detail in Chapter 2 of this report.

- Task 1. Review the Literature
- Task 2. Select Five Indirect Source Case Studies Sites
- Task 3. Conduct a Survey of Shoppers at Each Case Study Site
- Task 4. Select Travel Reduction Measures to be Evaluated for the Case Studies
- Task 5. Analyze and Summarize Data Collected
- Task 6. Develop an Analytical Methodology

An in-person survey was conducted at the five case study sites to collect traveler characteristics. The survey was designed to identify preferences among a cross-section of shoppers for different transportation strategies and to identify shopper attributes unique to particular centers. At least 300 surveys were conducted at each site; employees of the center and tourists were not included in the survey. The survey was administered over a five-day period that included a Saturday and, for the weekdays, covered the center's hours of operation.

Several significant conclusions emerged from the case study analysis. As expected, at all five sites, the most common reason for traveling to the shopping center was to shop at all five sites. Depending on the center, the percentage of people with this trip purpose ranged from forty to seventy-four percent. At three of the case study sites, eating out was the second most common reason for traveling to the shopping center, while personal errands was the second most common reason at the other two case study sites.

A summary of the mode of travel used to access each case study site was provided in Table 1-1. As the level of transit service and the density and intensity of the surrounding land uses increases, the transit and walk mode share also increase. Combined, the non-auto modes increase from 5.0 percent to 61.7 percent of travel to the shopping center. There is not a consistent pattern in auto use by number of occupants across the case study sites. As described in more detail in Chapter 3 of this report, of those that used transit, bicycled, or walked, approximately two-thirds had no car available for the trip. Of those that drove, approximately half had transit service available. At each of the case study sites, those whose primary trip purpose was shopping were more likely to travel by auto compared to the overall average. In general, the survey respondents had little difficulty finding parking (between sixty and ninety percent at each site), and most (between seventy-four and one hundred percent) did not have to pay to park at the shopping center. Even at the shopping center with a paid-parking garage, the average amount paid to park was low ($0.26) because of extensive parking validations offered by merchants.

Literature Review

Much of the literature related to the study of travel to shopping centers has focused on trip generation rates and parking requirements. There is much less information on the implementation of travel reduction measures at shopping centers or at indirect sources in general. The findings of the literature review are presented in Chapter 2 and Appendix A of this report. A summary of the key findings is presented below.

Table 1-2
CASE STUDY SITE CHARACTERISTICS

	SL1	SL2	SM	SH	UH
Location	Suburban	Suburban	Suburban	Suburban	CBD
Density of Surrounding Land Uses	Low	Low	Medium	High	High
Freeway Accessibility	Immediately adjacent	Immediately adjacent	One mile	Immediately adjacent	Two miles
Cost for Parking*	None	None	$0.03	$0.10	$0.26
Transit Service					
Routes	6 bus routes	4 bus routes	3 bus routes Shuttle to rail	11 bus routes	31 bus routes 3 light rail lines
Headways (minutes)	2 routes: peak: 30 off-peak: 60 4 routes: peak: 15-60 off-peak: 30-60	2 routes: 30 2 routes: peak: 15 off-peak: 30	bus routes: peak: 15-60 off-peak: 30-60 shuttle: 20	5 routes: peak: 5-40 off-peak: 12-30 6 routes: peak: 10-30 off-peak: 10-60	bus routes: peak: 6-30 off-peak: 30-60 Light rail: 15-30
Location of transit stop	2 routes: 50 ft from center 4 routes: 250 ft from center	On-site, covered shelter stop	On-site	Border of shopping center, 4 routes across street	23 bus routes: major transfer point All: border of shopping center
Bicycle Amenities	No bike lanes on arterials Bike trail 2 miles south	Two bicycle racks for 20 bicyles	None	Class II bicycle lanes adjacent to center and one block away. 99 bicycle parking spaces in parking structure.	Bicycle racks at trolley station
Pedestrian Amenities	Few dedicated walkways	Sidewalks from bus stop and on residential side of center	Sidewalks to adjoining areas	Sidewalks and crosswalks to all adjoining areas.	Sidewalks to adjoining areas

* Average over all vehicles per trip (includes validation)

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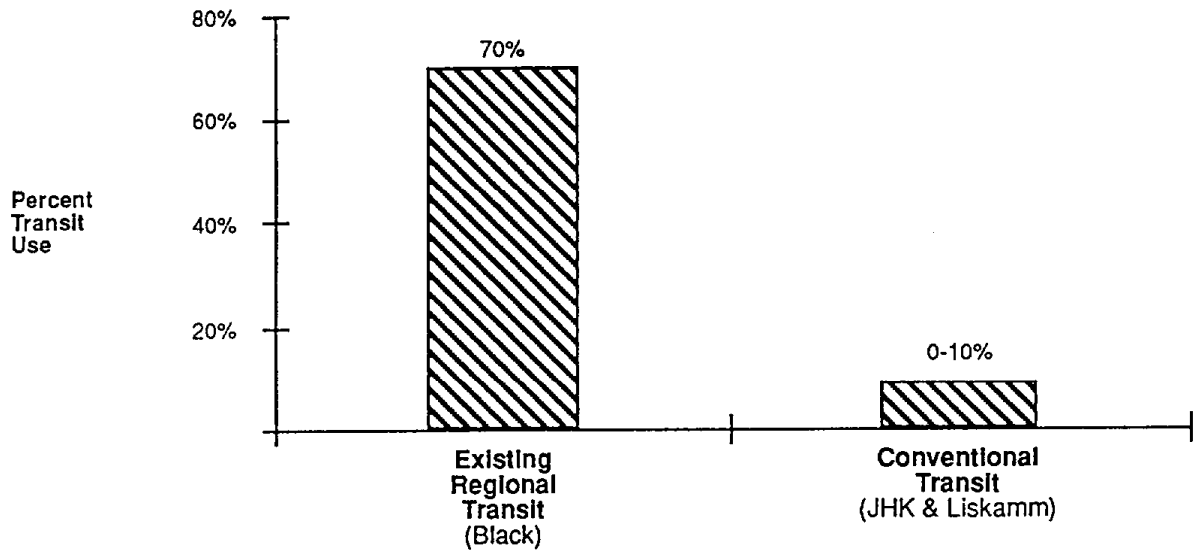

Figure 1-5
Transit Mode Share: Literature

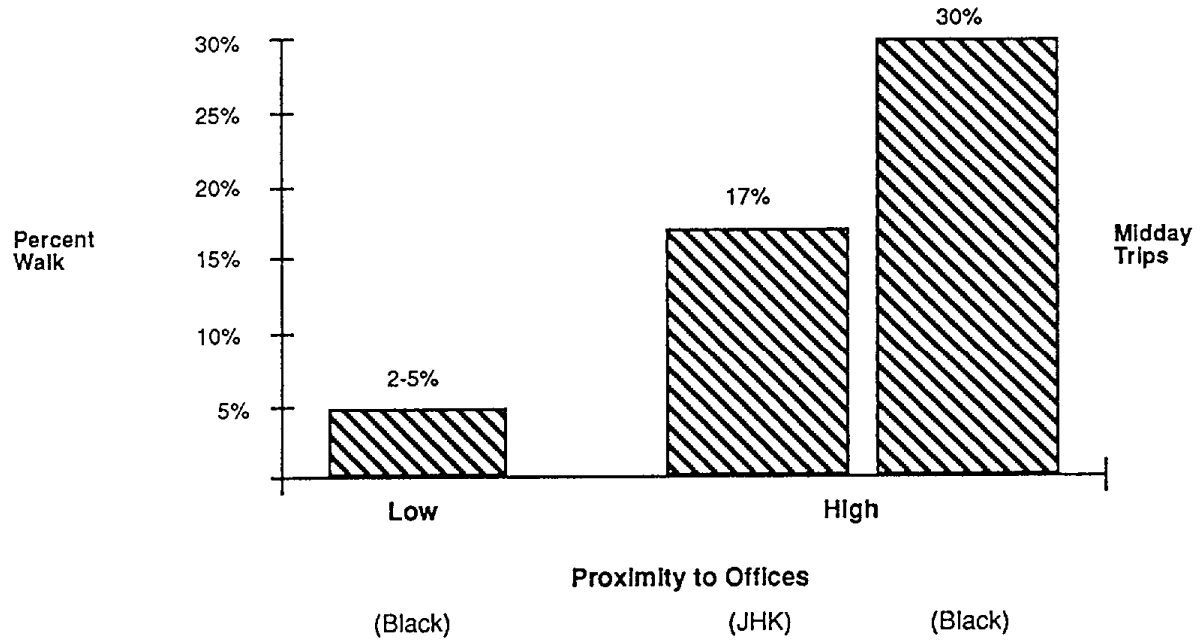

Figure 1-6
Walk Mode Share: Literature

Travel Characteristics

- Many linked trips or travelers who stop while passing by occur at shopping centers. These may not be easy to shift to transit.
- Average trip length varies considerably between shopping centers.
- Many transit trips to shopping centers are transfers to other transit lines.

Transit

- High transit shares (mode split percentages) are found only where an extensive regional transit system exists that provides direct service to the shopping center (see Figure 1-5).
- Modest increases in bus service capture only a few new trips.

Urban Design/Non-Motorized Access

- Increased proximity to office development results in increased walk mode shares of seventeen to thirty percent during the midday (see Figure 1-6).

- Shopping centers with little or no office development nearby generate only two to five percent walk mode share.

Parking

- Reducing the parking supply may have little impact on auto use for most of the year because the supply is generally designed for the tenth highest demand day of the year (Christmas season).

Technical Findings

- Some sensitivity factors or "elasticities" were identified for shopping and non-work trips.
- Most elasticities identified were based on changes in transit service. Few were based on changes in parking pricing, and none were based on changes in bicycle or walk facilities.
- Transit shopping trips are relatively sensitive to fare and service level changes.
- Shopping trips, and short-term trips in general, appear to be more sensitive to changes in parking pricing than are work trips.

Methodology for Evaluating Travel Reduction Measures

Using the empirical evidence from the literature review and the shopper survey, a methodology was developed to evaluate a range of travel reduction measures. This methodology was developed as a separate set of parametric equations for each measure to reflect its unique characteristics and expected impacts on travel mode choice. The data from the literature review and the shopper survey were used to shape the structure of the analysis and to provide values used in the analysis.

evaluate more frequent transit service, the analyst must specify the percent increase in transit vehicle miles serving the shopping center (defining the measure) and the current percent of trips made by transit (travel characteristic).

The third step of this analysis procedure is to identify site-specific assumptions, if available, to be used in the analysis rather than the assumptions documented in this report. These assumptions may be (1) elasticities related to changes in the level of transportation service as suggested by the literature or (2) a sensitivity value based on the stated preference of respondents in the shopper survey conducted for this study.

The final step in the application of the methodology is to use the equations developed to estimate the percent trip reduction. The estimation of the percent trip reduction is based on assumptions included in the analysis regarding the reaction of travelers to the measure as described in the input data. If data on the total number of trips made are available, excluding employee and tourist trips, then the calculated percent trip reductions can be used to estimate the daily trip reduction. It should be noted that the methodology is designed to evaluate each measure independently. Because of possible interactions between measures, it is not appropriate to simply sum the estimated reductions across measures.

The methodology was applied to the five case study sites to demonstrate the potential effectiveness of the travel reduction measures. The four-step process described above was followed, and measures that were not applicable to specific regional shopping centers were not included in the analysis.

1.4 RECOMMENDATIONS FOR FUTURE RESEARCH

This study is one of the first to assess travel mode choice and the potential effects of travel reduction measures at regional shopping centers. Through the course of the study, the project team has identified a number of areas, listed below, that would benefit from further research and study.

- Implement demonstration projects for travel reduction measures at regional shopping centers to better determine their effectiveness.
- Further specify the relationship of location of the shopping center and access to alternative transportation modes to choice of travel mode.

The methodology included all of the travel reduction measures studied except two: reduced walking distance from sidewalk to buildings and free home delivery of purchased items. A methodology for evaluating reduced walking distance was not applicable primarily because locating buildings closer to the sidewalk applies mostly to the design of new shopping centers. The focus of this study was on existing regional shopping centers rather than the development of new sites. In addition, there was no information available from the literature on the effects of altering walk distances for shopping trips. Free home delivery of purchases could apply to existing shopping centers, but the measure was not quantitatively analyzed, because by itself it may not encourage the use of an alternative transportation modes. Instead, it is likely to support other travel reduction measures by removing the concern of carrying packages on transit or a bicycle or while walking. Acting as a support mechanism for other travel reduction measures, free home delivery may produce better results for these other measures.

The methodology for each travel reduction measure is described in Chapter 5 of this report and in more detail in Appendix F. The methodologies are designed to enable an analyst to predict trip reduction at regional shopping centers in a sequence of four general steps.

Step 1. Determine whether the measure is applicable to a given regional shopping center.

Step 2. Specify input data describing the measure being evaluated.

Step 3. Identify more up-to-date or site-specific assumptions.

Step 4. Calculate percent trip reduction.

In performing the first step, an analyst reviews the criteria for determining whether or not the measure is applicable to a regional shopping center. If the criteria are met, then the analyst proceeds with the subsequent steps. If the criteria are not met, then the measure is not applicable to the regional shopping center and is not analyzed. For example, criteria for considering the feasibility of a shopper's shuttle include whether an existing transit system is in place to serve potential shuttle trips. If there is a transit system in place, experience indicates that a shopper's shuttle would replace many existing transit trips. Because the shuttle is not likely to produce a net benefit for the center, it would not be considered applicable in that situation. For most of the case study sites, all of the measures were applicable.

The second step in the methodology is to specify the input data defining the specific travel reduction measure and describing the travel characteristics for the shopping center. For example, to

2.0 PROJECT SCOPE AND PURPOSE

California has experienced a growth in population and travel that has led to increasing congestion in urban areas and to a worsening of air quality despite significant improvements in emissions control technology. The seriousness of these problems has been recognized by the state legislature, as is evidenced by the CCAA, passed in 1988 to improve air quality throughout the state. To comply with the requirements of the CCAA, local jurisdictions throughout the state are developing Air Quality Attainment Plans that include transportation control measures (TCMs), whose purpose is to reduce the amount of transportation-related emissions.

There is a growing awareness in the transportation profession of the importance of understanding the impact that transportation measures have on air quality, not just mobility and congestion. The passage of the CCAA has increased this awareness and has made it clear that air quality implications must be assessed for all proposed transportation projects. Significant research is also being performed on methods to reduce commute travel and thereby reduce emissions from these trips. Because of the research that has occurred, the characteristics of the commute trip are reasonably well understood and TCMs that are effective for reducing the impact of the commute trip on air quality have been implemented in many areas throughout the state.

The next transportation-related area in which significant emissions reductions can be achieved is the non-commute trip. Non-commute trips form the greater majority of all trips made, but they are less well understood because the reasons and the timing for individual trips are more varied. Most non-commute trips are to facilities such as shopping centers, sports facilities, and universities. These facilities are known as indirect sources. Research has been performed on indirect sources regarding trip generation rates and parking rates. A broader understanding of how and why these trips are made and what motivates an individual to use a particular mode has not been obtained through research prior to this project.

In this project, data have been collected to provide a better understanding of the travel characteristics of one indirect source, regional shopping centers. This understanding will support ARB's goal of reducing vehicle trips and miles traveled, as required by the CCAA. Five regional shopping centers located in metropolitan areas throughout the state were chosen as case study sites. The regional shopping centers were selected to represent a variety of characteristics (such as transit availability,

- Analyze the applicability of findings from this research to shopping centers in other areas, such as non-metropolitan areas, and to shopping centers that are not regional, such as neighborhood or community shopping centers.

- Examine the possible implications of a "recreational" trip purpose for mode choice and the impact of travel reduction measures.

- Perform additional research on elasticities and sensitivity factors for travel to shopping centers, especially for transit and walking/bicycling. This should include trip purposes other than shopping.

- Examine trip patterns to/from shopping centers and relationship to mode choice.

- Analyze the relation between multiple occupants in vehicles (family, work associates, etc.) and implications for consolidation of trips.

- Evaluate the relationship between stated preferences obtained in surveys and actual behavior.

These future research areas are described in Chapter 6 of this report. Conduct of these research efforts would lead to a more in-depth understanding of how to encourage alternative mode use to shopping centers.

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- *Task 5. Analyze and Summarize Data.* The data gathered in Tasks 2 and 3 were tabulated and summarized. The characteristics of the shopping centers were compared to the results of the shopper survey to determine which features of the centers had the greatest impact on mode of travel.

- *Task 6. Develop Analytical Methodology.* A methodology was developed to estimate the travel reduction achieved by the measures. The methodology provided a structure for the analysis that walks the analyst through the required steps and procedures. The development of the specific calculations was based on empirical data gathered from the literature review and from the shopper surveys.

- *Task 7. Conduct a Workshop.* A workshop was conducted for the staff of air quality control districts, transportation and transit agencies, local planning departments, shopping center representatives, and other interested parties. In this workshop, the findings of the study were presented. This included a summary of the data collected, the case study findings, the methodology developed, and future research needs.

- *Task 8. Prepare a Final Report.* This Final Report was prepared to document the work performed in the project and the conclusions reached.

An Advisory Committee was formed to review the progress of the study at key points, assist in the selection of the case study sites and review the analytical approach. Members of the Advisory Committee included representatives from air districts, metropolitan planning organizations, Caltrans and the shopping center industry. This variety of perspectives assisted in the development of an approach that included a variety of factors, such as identifying travel reduction measures that do not negatively impact the economic viability of the regional shopping center.

(#4070/CHAP2.FNL)

surrounding land uses, and parking conditions) to test whether differences in these criteria were related to differences in travel behavior among the case study sites.

The data collected in this study have been used to identify the land use and transportation characteristics of individual shopping centers that impact travel behavior and to develop an analytical methodology to evaluate the impact of travel reduction measures on trips and VMT at regional shopping centers. As a result of this project, a much better understanding has been developed of the nature of travel to and from regional shopping centers and how to reduce the emissions that occur from these trips. It should be noted that the shopping center industry participated directly in this project through the involvement of the case study sites and attendance at project meetings.

The project was organized into a series of tasks. A brief description of each task is provided below.

- *Task 1. Review the Literature.* A key step in the identification of potentially effective travel reduction measures for indirect sources was the review of national literature. Previous studies, surveys, planning documents, and other reports on indirect sources were reviewed, with special attention given to any information on shopping centers. The orientation of this task was on obtaining descriptive information on each of the measures found in the literature as well as specific information that could be used in the development of the analytical methodology.

- *Task 2. Select Indirect Source Case Studies.* Five regional shopping centers from various parts of the state were selected to reflect different characteristics that may affect the successfulness of a travel reduction measure. Data on the characteristics of each site were collected through a combination of a site visit to the shopping center and an interview with the shopping center management.

- *Task 3. Conduct a Survey at Each Case Study Site.* Site-specific data on the travel characteristics of shoppers (used to refer to all non-employees and non-tourists that travel to the shopping center) and interest in travel reduction measures were collected through an intercept survey at the case study site. A questionnaire unique to the needs of this project was developed and pretested at a regional shopping center not identified as a case study site prior to the conduct of the shopper surveys.

- *Task 4. Select Travel Reduction Measures for the Case Studies.* Travel reduction measures were selected that had the potential to be successful in impacting travel behavior, and for which data were available from the literature review or the shopper survey. Each measure that was determined to be appropriate for each case study site was evaluated using the methodology developed in Task 6.

3.0 DATA COLLECTED

To provide a basis for the evaluation of travel reduction measures at regional shopping centers, a number of data collection methods were used. These included a review of the literature, collection of site characteristic data at five regional shopping centers, and a survey of shoppers at the same centers to determine their travel patterns and preferences.

3.1 LITERATURE REVIEW

To gain an understanding of shopping center travel, an extensive review of literature documenting local, national and international research was performed. This review included literature on all types of shopping trips, not just those to regional shopping centers. Much of the applicable literature describes the characteristics of trips to shopping centers. Literature describing factors that contribute to the use of transit and other non-auto modes to shopping centers is much more limited because this has not been a concern in many areas until recently. The main points of the literature reviewed are highlighted below and a summary table is provided in Appendix B, along with a complete bibliography of reports and articles referenced. An annotated bibliography of those sources most directly applicable to understanding travel behavior at shopping centers is provided in Appendix C.

Travel Characteristics

The literature indicates the importance of assessing and understanding the shopping center market population and trip patterns to develop effective trip reduction strategies. Several sources indicate that trip lengths to shopping centers are variable (JHK & Associates, Kittleson, Barton-Aschman Associates), which is significant because transit modal share and transit strategy effectiveness depend in part on length of the trip. In addition, a considerable number of shopping trips to regional shopping centers may be linked trips or pass-by trips, which may affect the opportunity of using transit or other non-auto modes (Toth, Slade and Grove). Even if the shopping portion of a linked trip could be diverted to a non-auto mode, the other segments of the trip may still contribute to traffic congestion and pollution. The literature also indicates that expanding transit service may capture more transfer trips among (JHK & Associates) existing transit users than diverted auto user trips.

downtown San Diego, California (JHK & Associates), for example, indicated that up to thirty percent of shoppers at centers located near major office developments are office workers that walk from nearby offices, especially in the mid-day period. Similarly, another study found that seventeen percent of midday trips to centers in close proximity to office space are by walkers (Black), while only two to five percent of midday trips to centers with no office space nearby are by walkers. Likewise, centers serving tourists and suburban shoppers can be expected to find more auto use among patrons.

Parking

While there is little information on the relationship between parking availability and auto use at shopping centers, it does indicate that manipulation of the parking supply as a travel reduction measure requires caution. One study, for example, finds that peak-period demand for parking is not related to the amount of available parking (ULI). The reason for the finding may be that parking supply at shopping centers is generally quite ample compared to demand because it is often provided to accommodate peak parking demand during the holiday season. Thus, providing less parking may have little effect on parking demand during most of the year, and therefore on auto use, because supply is already ample compared to average daily demand, unless the supply is significantly reduced.

Technical Findings

In addition to the review of literature oriented to shopping center travel, a broader range of sources related to the understanding of travel characteristics were reviewed. The focus of this review was to determine whether there were findings in the literature that might be applicable to the evaluation of travel reduction measures at shopping centers. A summary of the most relevant technical findings are provided in Appendix D.

Unfortunately, much of the literature that examines the characteristics of travel deals with the home-to-work trip. Those technical findings that are not focused only on the home-to-work trip tend to examine all trips, or to combine all non-work trips together. There are some data available on shopping trips, but almost none on the other trip purposes related to a regional shopping center, such as entertainment or eating out, and many of the relevant findings relate to transit service. Notably, there have been few technical evaluations of travel reduction measures that are oriented uniquely to shopping centers, such as teleshopping, free home delivery services, and shuttle services.

Transit

Several of the sources describe the results of surveys in which shoppers' (including both users and non-users of transit) were asked what improvements to transit service would make it more attractive to them. The results from such "stated preference" studies consistently indicate that transit is a more attractive alternative to auto use when the service provided is direct and convenient. Direct service was reported to be more important than transit fare, frequency of service or the provision of benches and shelters in transit stop areas (Chambers, Greater Bridgeport, Couture).

Results from several of the surveys suggest that shoppers find transit more attractive than bicycling or ridesharing. Interest in transit strategies were consistently higher than the provision of pedestrian amenities, provision of bike lanes and storage facilities, and ridesharing incentives, such as carpool preferential parking.

The literature suggests that the potential for transit service to capture a large percent of shopping trips may be limited unless the area is served by extensive regional transit systems. In Boston and Philadelphia, for example, where the regional transit systems are extensive and comprised of a mix of rail and bus, the transit share for shopping trips is reported to be as high as seventy percent (Black). In contrast, several sources in the literature identified a transit share ranging from zero to ten percent for shopping trips to centers served by conventional bus transit (JHK & Associates, Liskamm). One of the literature sources reported no obvious relationship between the number of bus lines serving shopping centers and overall proportion of transit use, suggesting that modest changes in conventional service may not capture very many shopping trips. Similarly, another study (Tebinka) showed an actual decline in transit share after development of a bus transit center within a shopping center. The reason for the decline may be that a large share of transit trips to shopping centers are transfer trips, which was also indicated in the literature. Thus, improvements to transit may affect existing transit users more than auto users.

Urban Design/Land Use and Non-Motorized Access

Several of the sources described the relationship between land use (surrounding or internal to a regional shopping center), pedestrian amenities and the percent of walk and bicycle trips to the center. The literature indicates that the proportion of shopping walk trips is highly dependent on land uses nearby. The literature also suggested that nearby land uses may contribute more to the percentage of shoppers that walk than the pedestrian design elements provided at the center. One review of shopping centers in

3.2 CASE STUDY SITE CHARACTERISTICS

To supplement the literature review performed to identify travel characteristics at shopping centers, five regional shopping centers located in various parts of the state were included as case study sites. The five case study sites were selected to obtain variation in a number of characteristics, including transit service, density of surrounding housing, and whether there was a charge for parking. With only five sites, it was not possible to represent every combination of site characteristics; rather, an emphasis was placed on having variations across each characteristic so that the relationship between various characteristics and travel behavior could be examined. A summary of the site characteristics identified during the selection process is provided in Table 3-1 to describe the variability targeted. The sites have been assigned acronyms that correspond to whether they are in an urban (U) or suburban (S) location, and whether there is low (L), medium (M), or high (H) transit service and surrounding density of land uses.

Data were collected on the characteristics of each site to support the evaluation of the factors that are likely to influence the travel patterns to a regional shopping center. These data were collected primarily through on-site interviews with shopping center management. A summary of the data collected for each site is provided in the following sections. Some of these data are slightly different than those listed in Table 3-1 and are considered more accurate because they are the result of a primary data collection effort, rather than relying on secondary sources.

Case Study Site: Suburban, Low 1 (SL1)

The first case study site is an enclosed, two level super-regional shopping center located approximately four miles from the CBD in a metropolitan urban area in Northern California. The hours of operation for SL1 are 10:00 A.M. to 9:00 P.M. on Monday through Saturday, and 10:00 A.M. to 6:00 P.M. on Sunday. SL1 encompasses a total of 74.24 acres, including parking. This total includes parking for the adjacent shopping complex located immediately east of SL1, but it does not the adjacent shopping complex itself. SL1 has 1,163,500 square feet of gross leaseable area (GLA)

Adjacent Land Uses

SL1 is situated in a general commercial zone designated as C-2. The services in this zone are comprised of typical mall services such as small retail outlets and shops. Within a mile north of the shopping center, the land is zoned R-1 and consists of single-family dwellings with a density of 7 units/acre. To the south, the land is zoned as S-C (shopping center district) and land uses consist of shops, gas stations, hotels, offices, and 2-story apartments. The density of the multi-family residential zone (R-3) located within a mile south of the shopping center is 29 units/acre. A freeway is located directly to the west of SL1. Northwest of the freeway, the land is zoned for heavy commercial uses (C-4)

Appendix D provides a summary of literature findings on changes in the use of transit, parking and bicycling resulting from changes in prices and service variables. In some cases, the variation in use is given as an "elasticity." An elasticity shows how a one percent change in a variable, such as transit fares, affects another variable, such as use of transit. For example, based on studies in five cities, Ecosometrics found a "fare elasticity" for shopping trips of -0.23, meaning a one percent increase in fares gives a decrease in trips of 0.23 percent.

It is important to note that elasticities are specific to the price or service level at which they are measured, and are not necessarily reversible. For example, the transit fare elasticity found by Ecosometrics was derived from observed changes in shopping trips made by transit at the specific fare levels of the systems studied in five cities. The elasticity may vary at higher or lower fares. Also, the elasticity refers to changes in transit use due to an increase in fares. A decrease in fares may result in a different elasticity.

The table summarizes findings other than elasticities. For example, the ASCE study referenced under bicycling indicates a possible increase of seven to nine percent for shopping trips by bicycle with improved bicycle facilities. The final section of the table regarding stated preference studies summarizes how the actual use of transit compares to statements of intended use, obtained from surveys, prior to implementation of the transit service. Notice that actual use has been found to be 1/5 to 1/3 of stated intended use.

A few key technical findings may be summarized. These are provided below.

- Transit shopping trips are relatively sensitive to fare and service level changes, and generally more sensitive to service than fare changes. For example, elasticities with respect to travel time, access time, transfers and increases in bus miles generally are greater in magnitude than those with respect to fares.
- Prior mode of new transit users is an important issue. According to the Barton Aschman study, for example, transit service changes attracts new trips, auto passengers and others in addition to those that drove alone. Thus, an increase in transit use does not bring an equal decrease in auto use.
- Shopping trips appear to be quite sensitive to changes in parking pricing, as are short term trips generally, and as compared to work trips.

and consists of offices and light manufacturing. Stretching out 300 ft. southwest of the freeway is an M-2, heavy industrial zone, where the land use primarily consists of warehouses. The area within a mile east of SL1 is zoned for commercial uses, and land uses include commercial businesses such as retail outlets and restaurants as well as gas stations and a movie theater.

Parking

Of the 5,393 parking spaces provided by SL1, including forty-five spaces for handicapped persons and seven truck courts serving primarily semi-trailers, 4,643 are surface spaces surrounding the center. While there is no lease agreement between SL1 and the adjacent shopping complex, the adjacent complex shares some of these surface spaces. The remaining 750 spaces are in a three-level parking structure with one ground level and two levels above ground. Each floor of the parking structure has an area of approximately 81,250 square feet. An additional parking structure with 680 spaces is proposed in tandem with the JC Penney department store. SL1 does not provide exclusive carpool parking spaces.

Parking for shoppers in the surface lots and in the parking structure is free. The distance from the parking areas to the center ranges from 20 to 500 feet, with at least seventy-five percent of the spaces less than 300 feet away. Parking for employees is also free but is restricted to the perimeter of the surface lots, a restriction that is enforced by Parking Security only during pre-opening. Employers do not pay separately for parking.

Freeway Access

SL1 is located immediately adjacent to an Interstate freeway and is accessible from two exits. The western mall exit is less than one-quarter mile from one interchange. As identified by the May 1992 tenant opportunity report, SL1 is the area's only shopping center with direct freeway access. Connections are excellent between five major area freeways. SL1 is also accessible from the CBD via a state highway.

Non-Auto Access

The regional transit agency provides six different bus routes to SL1, four of which connect with light rail. Two buses run at thirty minute headways during the peak periods and at sixty minute headways during the off-peak periods. Headways for the other four buses vary from fifteen minutes to sixty minutes during the peak periods and from thirty minutes to sixty minutes during the off-peak periods.

Two bus stops with covered shelters serve SL1. One is approximately fifty feet from the center, while the other is approximately 250 feet away from the center. Two bus routes use the stop closest to the center, while the other four bus routes use the further stop when traveling inbound (toward downtown) and the closer stop when traveling outbound. The regional transit agency estimates the number of alightings at the closer stop to be between 30,000 to 45,000 per month. In addition, three hotels located adjacent to SL1 provide service to the shopping center using hotel shuttles.

Walk access to SL1 is possible from both the residential neighborhoods on the north and the mixed residential neighborhoods south of the center. SL1 management believes there is a significant number of patrons that walk to the center from nearby offices and residences; however, an arterial poses a major pedestrian barrier to restaurants, shopping, and hotels across the street. There are few dedicated pedestrian walkways within or through the parking lot. Bicycling also is undesirable on most adjacent arterials. Connections to a bike trail two miles south of SL1 are good, although the route is not frequently used.

Table 3-1
CHARACTERISTICS OF CASE STUDY SITES USED IN SELECTION PROCESS

Characteristics	SL1	SL2	SM	SH	UH
Location	Northern California	Northern California	Northern California	Southern California	Southern California
Urban/Suburban	Suburban	Suburban	Suburban	Suburban	Urban
Transit Service*	Low Capacity	Low Capacity	Low Capacity	Low Capacity	High Capacity
Parking Pricing	Free	Free	Some Metered/Valet	Some Metered	Hourly, Validation
Mixed-Use	No	No	No	No	Yes
Surrounding Housing	Some Single Family and Apartments	Single Family	CBD Area	Single Family and Apartments	Apartments, High Density
Socioeconomic Level	Medium	Med-High	Med-High	Med-High	Med-High
Market Population**	360,000	828,900	450,000	608,000	450,000
Marketing Strategy**	Traditional Mix	Traditional Mix	Upscale/ Fashion	Upscale/ Fashion	Upscale/ Fashion
Occupancy**	100%	99%	96%	95%	95%
Transportation Strategies	--	--	Shuttle to BART	Free Bus Ticket for $10 Purchase	--

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*Low versus high capacity based on whether there is rail service to the site.
** From *1992 Directory of Shopping Centers in the United States*, Western Volume.

SL1 has four major entrances; one of which is located at the site of the proposed JC Penney store. There are entrances on each side of the department stores. Information describing the delivery services to SL1 shops was not available.

Sales and Employment

Sales estimates for SL1 were not available from SL1 management for proprietary reasons. Approximately 2,500 people are employed at SL1.

Market Area Population

As estimated in a May 1992 tenant opportunity report, the market area for SL1 contains nearly one million people, which was estimated to be four times the size of the market area for an average regional mall. Nearly half of the residents in the SL1 market area are between twenty-five and forty-four years of age. Many are well-educated and earn strong incomes: fifty-three percent of the shopper households in the trade area earn over $35,000. A 1990 internal consumer research survey indicated that the average household income of the on-mall shoppers was over $41,000. SL1 captured twenty-six percent of the shopping trips made by market-area residents to five major area centers.

Case Study Site: Suburban, Low 2 (SL2)

First opened in 1986, the second case study site is an enclosed, two level super-regional shopping center located in Northern California. The hours of operation for SL2 are 10:00 A.M. to 9:30 P.M. on Monday through Friday, 10:00 A.M. to 8:00 P.M. on Saturday and 11:00 A.M. to 6:00 P.M. on Sunday. SL2 has 1,133,687 square feet of gross leaseable area (GLA).

Adjacent Land Uses

Within one-half mile north of SL2, the land is zoned for single-family residential with a density of 6 units/acre. Further north, stretching out to a mile, there are a mixture of small apartments and single-family homes with densities of 10-12 units/acre. West of SL2, land is set aside for commercial use. All the buildings are one-story constructions with densities of 20 percent floor area ratio/acre. The land directly to the east of SL2 is also commercial, although the developments are older than those in the west. There are several car dealerships in the commercial strip lying to the east and west. A major hospital/medical area is located within a half-mile east of the shopping center. This area includes several medical offices and the density is 35 percent floor area ratio/acre. There are no high-rise buildings in this area, although there are some multi-story (2-3 floor) stores. The land directly to the south for a distance of one-half mile is a mixed area comprised of another large shopping center, office buildings, and undeveloped properties. The density is approximately 20 percent floor area ratio/acre. One mile south of SL2 is a freeway. Beyond the freeway there are a mixture of commercial and residential land uses. The residential areas are primarily 2-story garden apartments with a density of 20 units/acre.

Parking

SL2 provides 6,080 parking spaces, seventy-six of which are allocated for handicapped persons. In addition to surface level parking, SL2 has a two-level parking structure. Parking is free and is within approximately 200 to 300 feet of the center. SL2 does not provide exclusive carpool parking spaces. Employee parking is free and provided in specific sections of the parking lots, although it is not strictly enforced.

Types of Stores

SL1 is currently anchored by three department stores, and a fourth is scheduled to open in October 1993. These four stores, identified below, occupy a total of 708,000 square feet of GLA.

Anchor Department Store	GLA Occupied (square feet)
Nordstrom	185,000
Sears	158,000
Weinstock's	205,000
JC Penney*	160,000

* JC Penney is scheduled to open in October 1993.

The remaining 455,500 square feet of GLA is occupied by approximately 170 smaller stores. The specialty stores can be divided into categories as shown below.

Store Category	Number of Stores
Apparel - Family	10
Apparel - Women's	23
Apparel - Men's	9
Apparel - Children's	6
Cards, Gifts and Books	7
Fast Food	15
Specialty Foods	8
Restaurants	3
Home Furnishings & Entertainment	11
Jewelry	11
Services	8
Shoes	10
Specialty	34
Specialty Women's	7
Total*	162

* The total number of stores was correct as of April 1992. The current total is 170.

Store Category	Number of Stores
Apparel - Women's	29
Apparel - Men's	12
Apparel - Children's	5
Family/Specialty	21
Footwear	17
Jewelry	9
Cards and Gifts	10
Home Furnishings & Entertainment	15
Specialty Stores	20
Services	3
Restaurants	2
Food Court	16
Packaged Food	10
Variety/General Merchandise	1
Health and Beauty	7
Total	177

SL2 has six major entrances. In addition to these entrances, each of the department stores have separate entrances. Each store receives approximately one to five deliveries per week. There is no delivery space or loading dock at SL2 and all deliveries are therefore made curbside; most deliveries are made before 10:00 A.M.

Sales and Employment

SL2 shops generate approximately $460 per square foot in sales annually. Approximately 3,000 people are employed at SL2.

Market Area Population

According to a 1992 study by the owners of SL2, the market population for SL2 contains approximately 665,000 people. The median household income of the SL2 market population is $55,000.

Case Study Site: Suburban, Medium (SM)

The third case study site is an open-air, one level super-regional shopping center geographically located at the southeast corner of a downtown in Northern California. SM is open from 10:00 A.M. to

Freeway Access

SL2 is visible and directly accessible from an Interstate freeway. SL2 is also accessible from a second Interstate freeway.

Non-Auto Access

The regional transit agency operates four bus routes that serve SL2. SL2 has an on-site, covered-shelter transit stop located in the parking lot of the center. Bus service begins each day at approximately 5:30 A.M. and runs until as late as 12:00 midnight, depending on the route. One of the bus routes serving SL2 stops running at 6:30 P.M. Two of the bus routes run at thirty minute headways all day long, while the other two run at thirty minute headways all day except during the peak, when they run at fifteen minute headways. There is no rail service to SL2.

SL2 provides pedestrian access sidewalks through the parking lot from the bus stop and from the residential side of the center. In addition, SL2 provides two bicycle racks that accommodate twenty bicycles.

Types of Stores

SL2 encompasses ninety-three acres. SL2 is currently anchored by three department stores that occupy a total of 716,500 square feet of GLA.

Anchor Department Store	GLA Occupied (square feet)
Nordstrom	150,000
Emporium	250,000
Macy's	316,500

The remaining 417,187 square feet of GLA is occupied by approximately 177 smaller stores (including restaurants and food court businesses). SL2 also has a bank located on site. The other specialty stores can be divided into categories as shown below.

Non-Auto Access

Region-wide rail service and is provided and a rail station is about one mile from SM. A free shuttle runs between this station and SM every twenty minutes between 7:00 A.M. and 7:00 P.M. Monday through Friday. On Saturday the shuttle costs $1.00 and runs every hour.

The regional transit agency provides bus service with three different routes that provide connections to five additional lines. There are three bus stops with covered shelters located on a street that runs through the middle of SM. Headways for one bus route are twenty minutes during peak periods and sixty minutes during off-peak periods. Headways for the other two bus routes vary from fifteen minutes to sixty minutes during the peak periods and from thirty minutes to sixty minutes during the off-peak periods.

Foot traffic is possible from both the residential neighborhoods on the east and south as well as from the downtown areas to the north and west of SM. SM management believes there is significant foot traffic from nearby offices and residences, and that SM is a major destination for pedestrians in the area.

While no bicycle racks are currently available, three racks will be installed in the near future. A bicycle path through the city is being planned and would include the street that bisects the shopping center.

Types of Stores

SM is anchored by three department stores, identified below, that occupy a total of 445,497 square feet of GLA.

Anchor Department Store	GLA Occupied (square feet)
Nordstrom	185,241
Emporium	190,000
I. Magnin & Co.	70,256

The remaining 225,982 square feet of GLA is occupied by approximately 85 smaller stores. Each store has its own entrance, and three department stores having multiple entrances. The management categorizes the other approximately 85 specialty stores as follows:

9:00 P.M. on Monday through Friday, and from 10:00 A.M. to 6:00 P.M. on Saturday and Sunday. SM encompasses a total of 14.5 acres, including parking. This total acreage may also include an adjacent Emporium and restaurant. SM has 671,479 square feet of gross leaseable area (GLA).

Adjacent Land Uses

SM is located in a downtown "core area". The floor area ratio for SM is .75. Within half a mile west and a quarter mile north, the land is zoned for pedestrian retail (P-R) and caters primarily to foot traffic. The pedestrian retail zones have floor area ratios between 0.5 and 2.0. The services provided in this area include personal services (e.g., beauty salons), restaurants, retail and some administrative offices. This is a very high-density area, although none of the buildings are more than 2 storys high. Parking is extremely scarce in this area, and there are currently only two city parking garages (one is still under construction), and some parking spaces at the shopping center. Further north, within a half-mile of the shopping center, there is an office zone (O-C) with floor area ratios between .5 and 2.0. The land uses beyond the office zone (three-quarter mile to a mile north of SM) are mainly commercial (e.g., auto service). Between one-half mile south and a quarter mile east, the land is zoned for office use (R-O). The land uses in this area are a combination of offices and some retail, and the floor area ratios average between 0.5-0.6. Further south (beyond half a mile), the land use is high-density residential (the density varies between 30-50 units/acre). Further east (beyond a quarter mile), there are a mixture of apartments and condominiums with densities of 10-30 units/acre. Beyond the multi-family residential zone are low-density single-family homes with densities of 3 units/acre.

Parking

Of the 2,736 car parking spaces provided at SM, thirty-seven are handicapped parking spaces and 279 are surface spaces surrounding the center. The other 2,457 spaces are divided between two parking structures, an older one with two levels and a new multi-story garage with five levels. The two level structure has 550 spaces assigned to Nordstrom and 1,120 spaces for the adjacent Emporium, while the multi-story garage has 787 spaces. Security at the multi-story garage is considerable, with a twenty-four-hour guard watching cameras that monitor all parts of the facility. Plans to build additional retail stores in the horseshoe shaped parking area will eliminate eighty-three spaces. There are no exclusive carpool spaces at SM. There is also metered parking on the streets bordering SM and in the downtown area.

Parking for shoppers is free both in surface lots and in the parking structure. The distance from SL1 to these spaces ranges between 20 and 300 feet, with at least eighty percent of the spaces less than 200 feet from the center. Parking for employees is free but is restricted to the perimeter of the surface lots. The restriction is enforced by parking security only during pre-opening. Employers do not pay separately for parking.

Freeway Access

SM is located within one mile of the junction of two freeways. Several exits provide access to SM.

on 6:00 P.M. on Sunday. Operating hours for the food court located within the shopping center are from 7:00 A.M. to 10:00 P.M. on Monday through Saturday and from 7:00 A.M. to 7:00 P.M. on Sunday. According to the *1992 Shopping Center Directory* published by the National Research Bureau, SH has three levels and has a total of 564,000 square feet of gross leaseable area (GLA).

Adjacent Land Uses

SH is situated within a commercial zone classified as C-3. Within half a mile north of the shopping center there is a residential zone with multi-family units (R-3) where the density is 1 unit/1250ft^2 parcel of land. Approximately 800 feet west of the shopping center on the ocean side, the land is zoned for residential uses and is comprised of small beach lots. The densities in this R-2-B zone vary between 1DU/1500ft^2 for parcels of land greater than 4000 feet and one single-family unit per parcel of land less than 4000 feet. 200 feet west there is a R-V-C residential commercial zone. The services in this zone essentially cater to tourists and are comprised of small retail stores and hotels. Directly south of SH, there are two commercial zones designated as C-C and C-3. A Civic Center that houses municipal courts and a large corporation is located in the C-3 zone. Stretching out approximately 400 feet east, there is a commercial zone (C-3-C) comprised of retail stores and offices. All the buildings in this zone have their ground floors set aside for pedestrian-oriented activities (shops, etc). Offices are situated above or in the rear portion of buildings. Within 500 feet southeast, there is a manufacturing zone where land uses consist of light manufacturing, assembling parts, warehouses, fabricators, and art studios.

Parking

SH is served by two on-site parking structures that are owned by the city and are attached to the center. One parking structure is positioned on the northeast corner of the site while the other is situated on the southwest corner of site. The parking structures have six floors and provide approximately 2,020 parking spaces in each structure.

All parking garage patrons receive three hours of free parking and do not receive time-stamped parking tickets because there are currently no attendants or booths located at the exists. Handicapped parking is provided, along with four spaces that are allocated for shopping center management. While the City is responsible for monitoring the parking structures and issuing tickets for parking violations, SH is responsible for the maintenance of the parking structures.

During evenings and weekends, the SH parking garages are heavily used by patrons of a closed-off street adjacent to the center that accommodates only pedestrian and bicycle traffic and has several nightclubs, restaurants, retail shops and movie theaters. SH management is currently considering establishing an evening and weekend parking fee to address the use of the SH parking garages by patrons to the adjacent area. There is no on-street parking provided on streets bordering SH. Where on-street parking is allowed on the local street system, it is usually metered and has peak-hour parking restrictions.

Freeway Access

SH is located one block south of the terminus of an Interstate exit. Major north-south roadways in the area supporting automobile access to SH include a State Highway. There are also a number of major boulevards providing east-west automobile access.

Store Category	Number of Stores
Apparel - Family	8
Apparel - Women's	21
Apparel - Men's	4
Apparel - Children's	1
Cards, Gifts and Books	10
Fast Food	1
Specialty Foods	5
Restaurants	4
Toys, Hobbies and Entertainment	5
Jewelry	5
Services	4
Shoes	2
Household	13
Other	2
Total	85

Each SM store receives deliveries (usually made by a UPS-type of truck) once each day, typically before 10:00 A.M.. On average, SM receives five deliveries by semi-trailer trucks per day. Nordstrom and Emporium have their own loading docks, while the new multi-level parking structure has a loading area for I. Magnin and the stores bordering the new parking structure.

Sales and Employment

Sales estimates for SM were not available from SM management for proprietary reasons. Approximately 2500 people are employed at SM.

Market Area Population

The primary market area for SM contains nearly 275,000 persons. Market area residents have a median household income of $59,655, which is well above the state's average income. According to the shopping center management, the average SM customer is a married woman from the area between the ages of thirty and fifty.

Case Study Site: Suburban, High (SH)

The fourth case study site is a regional shopping center first opened in 1980 and located in Southern California, just one block east of the Pacific Ocean. The city in which SH is located has a resident population of approximately 16,000 located in the midst of a large metropolitan area. Operating hours for SH shops are from 10:00 A.M. to 9:00 P.M. on Monday through Saturday, and from 11:00 A.M.

300 truck deliveries and pick-ups are made per week. A majority of the trucks arriving at the two loading docs are UPS-type vehicles.

Sales and Employment

Total annual sales for SH is estimated at $150 million. SH employs approximately 1,200 people.

Market Area Population

According to the 1992 *Shopping Center Directory*, SH has a market population of 608,000 people. Research conducted by SH management indicated the following about the center's market population:

- average household income is $58,000
- thirty-seven percent of the market area population earn over $50,000
- seventeen percent of the market area population earn over $75,000
- average age is thirty-seven years old; and
- the majority of the works in the market area population hold white collar, professional and/or technical jobs.

Case Study Site: Urban, High (UH)

The fifth case study site is a super-regional shopping center that first opened in 1985. UH, which functions as both a retail shopping center and an entertainment center, is located in the downtown of a Southern California city. It is surrounded by businesses, hotels, light rail, train and bus service, the courthouse and residential developments. The hours of operation for UH are 10:00 A.M. to 9:00 P.M. on Monday through Friday, 10:00 A.M. to 6:00 P.M. on Saturday and 11:00 A.M. to 6:00 P.M. on Sunday. UH occupies 6.5 city blocks and contains approximately 879,000 square feet of total leaseable area.

Adjacent Land Uses

Directly north and west of UH for a distance of one-half mile lies a commercial office district with a floor area ratio of 10.0. There are a mixture of high-rise, mid-rise, and low-rise commercial buildings and hotesl within this area. Approximately three blocks north of the shopping center (900 feet) lies a Civic Center where the floor ratio is 8. The land users to the south are essentially mixed, comprised of residential, multi-family units as well as hotels. Immediately east and southeast of UH stretching out 600 feet, lies an entertainment area with lots of pedestrian nighttime activity. The floor area ratio in this area ranges from 4 to 6. Past this area, the land use is mixed/residential, consisting of semi-industrial type warehouses, automotive services, large-scale furniture houses, single family and apartment buildings.

Parking

UH has two attached seven-level parking garages providing a total of 2,400 parking spaces for shoppers and employees. The garages, which cost $17 million to build in 1985, are open twenty-four hours a day, 365 days a year. While the cost for shoppers to park is $1.00 per half hour, shoppers get three hours free with a validation from a mall shop. Employee parking is restricted to certain levels of the parking structures and costs $60.00 per month, or $3.00 per day. The theatres validate up to four hours of free parking with the purchase of a ticket.

Non-Auto Access

Public bus service surrounding SH on all sides is provided by a city (6 routes) and a regional (5 routes) transit system. All of the bus routes have stops on the streets immediately bordering the center. Where the stop is across the street, pedestrian crosswalks and signal phasing are present to facilitate crossing the street safely. In addition, bus service is provided to a rail station in a nearby metropolitan area.

Pedestrian access is facilitated by crosswalks at all intersections located adjacent to the center. Pedestrian phasing and push buttons are also provided at all intersections. Sidewalks are provided from all bus stops servicing the center and to all areas surrounding the center. Additionally, curbs at all access points bordering the center are constructed for handicap access.

TCMs at the Site

SH currently offers one free bus pass to patrons that spend $10.00 or more at the center. The passes are honored by both the city and regional transit systems. Transfer connections are available between these and other nearby transit systems.

The shopping center is frequented by tour bus operators. While SH has no agreement with any bus line, a bus cut-out was constructed on the west side of SH. The cut-out operates as a two-hour buses-only parking zone and is used by the tour bus lines while their riders shop at SH. Additionally, several local hotels provide shuttle bus service to and from SH for hotel guests and employees. Tourists were not included in the survey.

Bicycle access to SH is provided by a Class II bicycle lane on a one-way westbound roadway that is located on the north side of the center. Class II bicycle lanes are also provided on both sides of the street one block southwest of the center. A total of 99 individual bicycle parking spaces are distributed at six locations underneath the cover of the parking structures.

Types of Stores

SH offers a wide range of national clothing, shoe, cosmetics and sports chain stores along with numerous specialty stores and restaurants. Since 1990, SH has contained a majority (sixty-five percent) of either new or remodeled stores. The main focus of the remodeling effort has been to attract patrons by providing "updated and advanced" fashion shops such as Benetton and Oaktree.

SH is anchored by two department stores, Robinson's and The Broadway, that occupy a total of 283,000 square feet of GLA. The remaining 281,000 square feet of GLA is occupied by approximately 147 smaller stores. The GLA per department store is shown below.

Anchor Department Store	GLA Occupied (square feet)
Robinson's	131,000
The Broadway	152,000

The number of truck deliveries to SH shops varies greatly throughout the shopping center. SH management does not track the number of truck deliveries made to the stores, but estimated that 200 to

Store Category	Number of Stores
Apparel - Women's	10
Apparel - Men's	5
Apparel - Family Specialty	21
Children's Apparel and Toys	7
Shoes	8
Sports Apparel and Equipment	6
Jewelry and Accessories	7
Specialty Stores	21
Fine Dining	6
Food Court	15
Specialty Foods	4
Card, Gifts and Books	4
Galleries	4
Home Entertainment	5
Services	15
Entertainment and Arts	3
Gourmet Grocery/Drug Store	2
Total	143

Sales and Employment

Total sales for UH in 1992, excluding department stores, was approximately $120 million. Approximately 2,500 people are employed at UH, although the number of employees varies by season.

Market Area Population

The *1992 Directory of Shopping Centers*, reports that the market area population for UH is approximately 450,000 people.

3.3 SHOPPER SURVEY

An in-person survey was conducted at the five case study sites to collect traveler characteristics. A minimum of 300 surveys were conducted at each site. The survey was designed to identify preferences among a cross-section of shoppers for different transportation strategies and to identify unique shopper attributes at particular centers. In particular, the survey assessed:

Freeway Access

UH is located within two miles of two freeways, and within eight miles of three other freeways.

Non-Auto Access

UH is served by thrity-one bus routes, all of which stop on at least one of the streets bordering the center. In addition, twenty-three of the thirty-one bus routes stop at a major transit transfer point located adjacent to the center. Headways for the buses serving UH range from six minutes to thirty minutes during the peak period and from thirty minutes to sixty minutes during the off-peak period.

UH is also served by the three lines of the area's light rail system. There are four light rail stations within walking distance of the center, one of which is a transfer point for commuter rail travelers. Bike racks and free enclosed lockers are available at some light rail stations.

Light rail headways range from fifteen minutes to thirty minutes depending on the time of the day. Transfers from light rail to bus and from bus to light rail are easy: a light rail ticket allows a traveler to transfer to bus, and bus travelers receive transfer slips to ride the light rail. If the light rail fare exceeds the bus fare, the traveler pays the difference.

Types of Stores

UH is anchored by the four department stores identified below. According to the *1992 Directory of Shopping Centers*, these departments stores occupy a total of 488,000 square feet.

Anchor Department Store	GLA Occupied (square feet)
Nordstrom	147,000
Mervyn's	85,000
The Broadway	135,000
Robinson's	121,000

The remaining 391,000 square feet of GLA is occupied by approximately 141 smaller stores. The entertainment center includes two theatres. The other specialty stores can be divided into the following categories:

- SM: September 29th to October 10th
- SH: September 22nd to 26th
- UH: October 6th to 10th.

On the weekdays (Tuesday through Friday) the surveys were conducted from 10:00 A.M. to 7:30 P.M., and on Saturdays, surveys were given between 10:00 A.M. and the midafternoon.

Three of the shopping centers allowed the interviewers to conduct the surveys anywhere within the center, and two of the centers limited the interviewers access to just the higher volume locations. Before beginning the survey, three criteria were used to screen the interviewees; they had to be older than 16, not employed at the center and be a resident in the area. Interviewers approached the shoppers at random so that there would not be a bias in the characteristics of the respondents.

Incentives provided to interviewees were supplied by the shopping center. These were offered after the respondent agreed to participate to encourage completion of the survey, but not impact whether they decided to participate. The incentives offered at each of the shopping centers were varied; two offered free yogurt to the interviewees, one provided a free coffee mug, one provided a free pin or tie tack, and one of the shopping centers provided no incentives.

Observations of Interviewers

The interviewers noted that the rate of refusal varied between shopping centers, however, most of the interviewees who started the survey, also completed the survey. One center that had a higher rate of refusals than the others was in a higher income area and had a few hours of rain on the first day. Two other centers had higher refusals due to the length of the survey, however, even the highest rate of refusal was only one in four shoppers approached.

Some demographic observations were made by the interviewers at each of the shopping centers. SL1 was noted to have an even mix of gender and age, with many families present. More senior citizens were noticed at SL2, and SM was distinguished by a larger number of women and middle-aged shoppers. SH appeared to be a younger mix of shoppers, with a beach and tourist orientation. More men and senior citizens were observed at UH.

Case Study Site: SL1

Demographic Characteristics

Key demographic characteristics for SL1 are illustrated in Figure 3-1. Approximately twenty-seven percent of the survey respondents at SL1 were 25 to 34 years old, and eleven percent were in the 16 to 17 age range. A total of forty-three percent of the respondents fell into the household income range $35,000 to $75,000, with a median income between $35,000 and $49,000.

The respondents were almost equally divided between men and women, at forty-seven percent and fifty-three percent, respectively. Fifty-two percent of those surveyed are employed full time, fourteen percent are full-time students and eleven percent are full-time homemakers.

- demographic characteristics, including age, income, gender and employment status;
- household characteristics, including number in household and vehicles in the household;
- trip characteristics, including trip purpose, trip length, parking fees paid and ease of finding parking;
- travel alternatives, including mode of travel, knowledge of alternatives to driving, reason for not using transit and availability of an auto for the particular shopping trip;
- reactions to several travel reduction measures including, free transit ticket, shopper shuttle, reserved carpool parking, bicycle lanes, better pedestrian access and walk distances, free home delivery and order by phone and computer; and
- reactions to increased parking fees.

The survey data from each case study site were used to evaluate trip reduction measures and to analyze the variation in mode of travel to regional shopping centers.

Survey Methodology

The survey questionnaire was designed to elicit a variety of demographic and travel characteristics. These questions were reviewed by ARB and the management at each shopping center. A primary emphasis in the design of the questionnaire was to make it easy to understand and administer, and to keep the length of the interview down to twelve minutes.

For some issues, the questionnaires were tailored to reflect the characteristics of each of the shopping centers. These were questions such as those regarding paid parking and a few site-specific items at the request of the shopping center. An example of the survey can be found in Appendix E.

The interviewers were briefed on the procedure for conducting the interview, and the questionnaire was reviewed in detail. The same experienced interviewing staff was used at each of the sites, providing continuity and consistency in the interview technique.

Conduct of the Survey

Each of the surveys were conducted over a five day period, which included a Saturday. The survey dates for each shopping center were as follows:

- SL1: June 15th to 20th
- SL2: September 8th to 12th

Household Characteristics

Sixty-five percent of the households represented consist of two to four people, with a total of thirty-two percent living in two-person households. Almost half of the respondents (47.7 percent) have no children under 18 living in their households, and forty-five percent have one or two children under 18. Approximately 29 percent of all surveyed households also have children under 6 living in their households.

Roughly half of those who responded have two employed adults in their households; however, nineteen percent of the total survey respondents did not provide an answer to this question. Thirty-seven percent of the households have one working adult, and fourteen percent have no working adults in their households. Of those who responded to the question, forty-eight percent have two vehicles available in their household, twenty-three percent have three vehicles and ten percent have four vehicles available.

Trip Characteristics

For seventy-three percent of the respondents, shopping was the primary purpose of their trip. Eating out was the most common secondary pupose, with twenty-five percent giving this response. Ninety-five percent of those surveyed came the the shopping center by car, 4.3 percent by bus. One person came by motorcycle (0.3 percent), and two respondents walked to SL1 (0.7 percent).

Over forty percent of the respondents traveled more than ten miles to get to the shopping center, and of these, twelve percent had traveled twenty or more miles. The trip to the shopping center took an average of 20.7 minutes for all respondents. Over four-fifths of the respondents were planning to spend at least an hour in the shopping center, with more than half of those people planning to spend at least two hours at SL1. Parking is free of charge, and most respondents indicated that they had little or no difficulty in finding a parking space (74.9 percent).

Travel Alternatives

Fifteen people (5.3 percent) to came to the shopping center by a mode other than by auto; five had a car available for the trip and six had a driver's license. Of those who came by auto, 50.9 percent knew of transit service available for their trip, 21.8 percent did not know if transit was available, and 27.4 percent were certain that transit was not an option for this trip. In addition to lack of access to transit, some common responses to a question about why transit was not used were: takes too long (forty-six responses), difficulty traveling with infants or large packages (twenty-four responses), lack of knowledge about transit system or schedules (twenty-three responses) and safety concerns (seventeen responses).

Travel Reduction Measures

Respondents were asked what their level of interest was in a number of travel reduction measures, and a summary of their responses is illustrated in Figure 3-2. Reserved parking for carpools was the travel reduction measure in which most respondents indicated some interest (63.8 percent). This measure is closely followed by a high level of interest in free home delivery, with a total of sixty-two percent responding that they were either very interested or somewhat interested.

A question was then asked regarding which of the measures were most likely to influence them to travel to the shopping center by a mode other than auto. A free bus or light rail ticket for making purchases was the travel reduction measure cited by the most respondents as likely to influence their decision to not drive to the shopping center (28.7 percent). Nineteen percent of the respondents felt that a shuttle service between the light rail station and the shopping center would be a measure that would be likely to influence a decision to not drive. Other influential measures were: more frequent RT bus or light

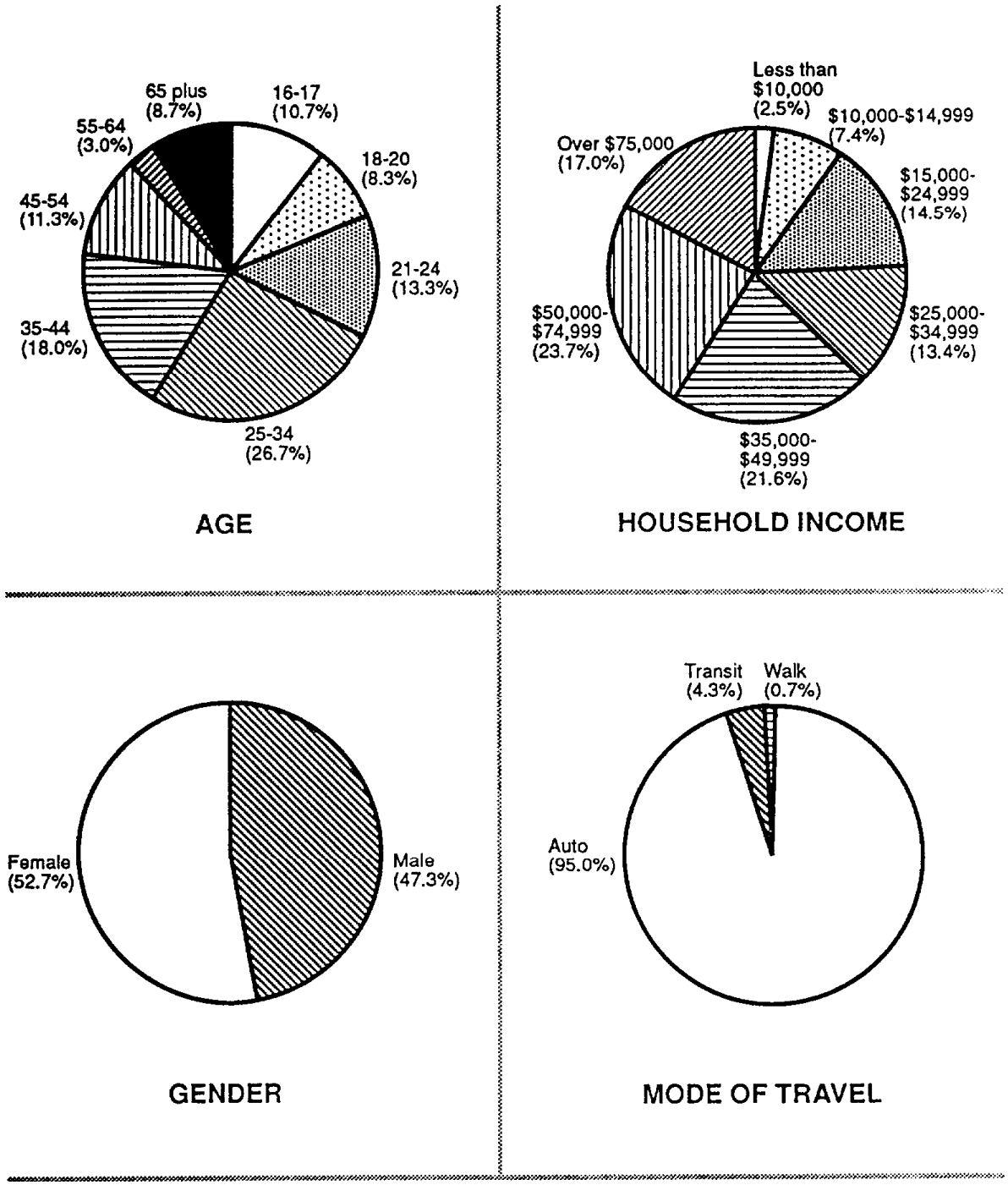


Figure 3-1
SL1: Selected Characteristics of Survey Respondents

rail service (17.0 percent), reserved parking for carpools (15.7 percent) and the ability to order items by phone (16.3 percent). Twenty-two percent of the respondents indicated that none of the measures would be likely to influence their decision.

Parking Measures

Almost half of the respondents (48.4 percent) indicated that they would shop elsewhere if a fee of $0.50 per hour was charged for parking. Some respondents would make fewer trips (15.5 percent) and fourteen percent would continue to drive regardless of the fee. If the fee were raised to $1.00 per hour, the percentage who stated that they would continue to drive dropped to three percent, while more people indicated that they would park outside the center (18.7 percent) or use another mode (17.5 percent). If the parking fee were raised to $2.00 per hour, most respondents would use some strategy to avoid paying the fee at all; either park outside (22.6 percent), use another mode (21.9 percent) or, still by far the most popular option, shop elsewhere (52.0 percent). Very few of those surveyed would continue to drive (1.3 percent) or use the strategy of making fewer trips (2.3 percent) to save on parking costs.

Case Study Site: SL2

Demographic Characteristics

Key demographic characteristics for SL2 are illustrated in Figure 3-3. Approximately thirty percent of SL2 respondents were in the 25 to 34 age range, with three quarters falling between the ages of 21 and 54. There were ten respondents (3.2 percent) in the 16 to 17 age range, and nine percent who were 65 or older. More than forty-five percent of the households represented by the surveys reported annual incomes greater than $50,000 and fewer than ten percent reported household incomes of less than $15,000 per year.

The number of women surveyed is approximately sixteen percent greater than the number of men surveyed, (57.9 percent and 42.1 percent respectively). Half of the respondents work full time (51.5 percent), 10.9 percent are retired, 8.7 percent are full time students and 6.1 percent are homemakers.

Household Characteristics

The average number of people per household is 3.32; almost one-third have at least one child younger than 18, and 15.7 percent have children under six. Almost sixty-four percent of the households contain two or more working adults, and 10.9 percent have no employed adults. The average number of vehicles per household is 2.6; 45.4 percent of the households have two cars available, and 36.1 percent have three or more cars available.

Trip Characteristics

The most common purpose for the trip was for shopping (74.0 percent); the most common secondary purpose was eating out. Over ninety-one percent of the respondents came by car, with an average of 1.7 people per vehicle, 6.4 percent traveled by bus and just a few by bicycle or walking (2.6 percent, combined).

The majority of the shoppers surveyed traveled between two and ten miles to the center (64.1 percent), with an average trip time of eighteen minutes. The average expected length of time in the shopping center was one hour and forty minutes. Parking is free of charge at SL2, and more than ninety percent of the respondents indicated that they had little or no difficulty in finding a parking space.

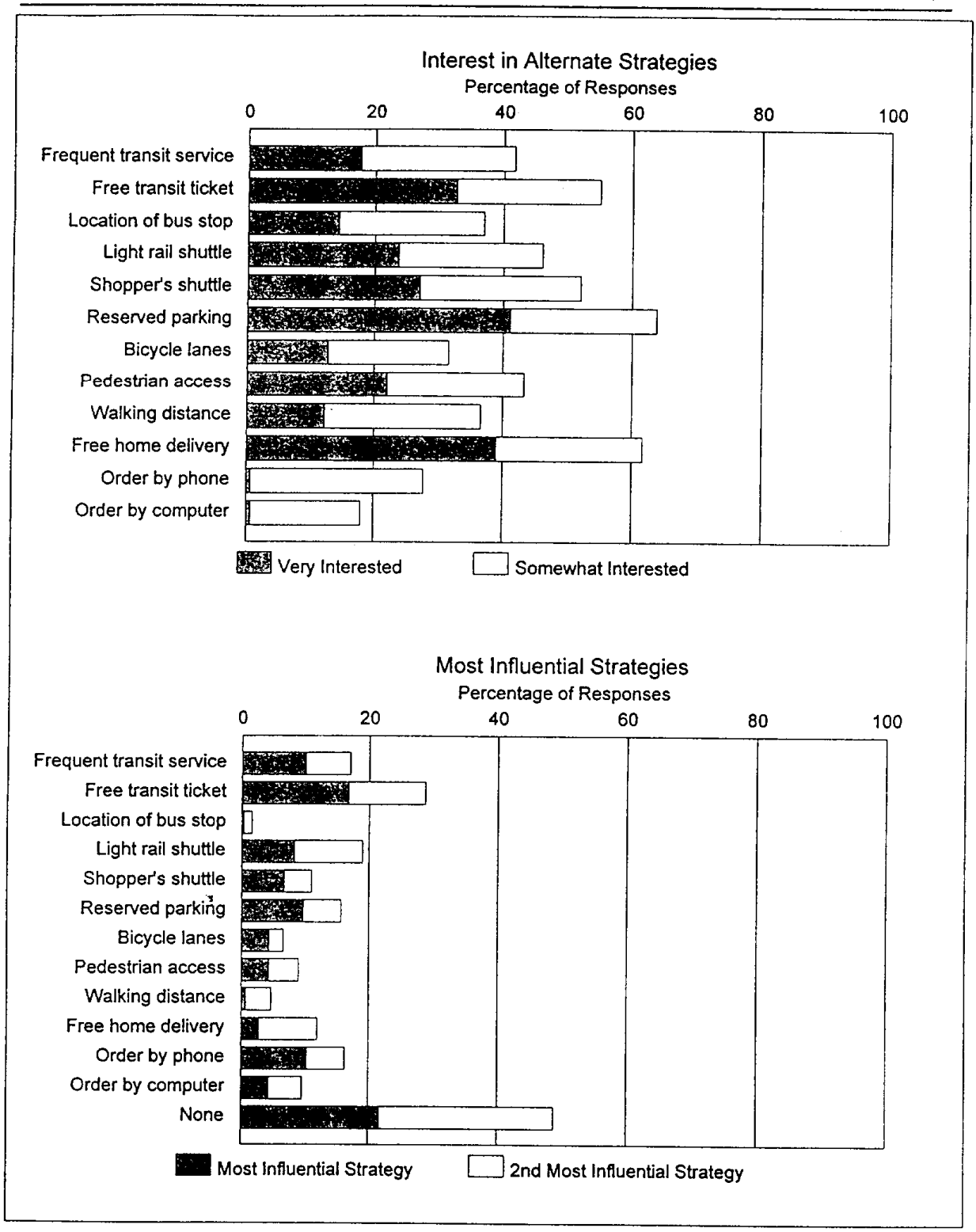


Figure 3-2
SL1: Response to Travel Reduction Measures

Travel Alternatives

Twenty-nine people to came to the shopping center by bus, bicycle or on foot (9.3 percent). Ten of these people had a car available for the trip (34.5 percent) and nineteen have a driver's license (65.5 percent). Of those who came by car, 45.4 percent knew of transit service available for their trip to SL2, 25.7 percent did not know if transit was available, and 28.9 percent were certain that transit was not an option for this trip.

Travel Reduction Measures

Respondents indicated the highest level of interest in free home delivery as a the travel reduction measure (78.6 percent). This measure is followed by a high level of interest in the free transit ticket strategy, light rail shuttle and more frequent transit service. Each of these strategies have a minimum of fifty percent of respondents showing that they were either very interested or somewhat interested. A summary of responses is illustrated in Figure 3-4.

Despite the high level of interest in free home delivery shown in the previous question, 16.3 percent of the shoppers responded that it was the measure most likely to influence their decision not to drive to the shopping center. A free bus or light rail ticket for making purchases was the travel reduction measure cited by the most respondents as most likely to influence decision to not drive to the shopping center (28.4 percent). Twenty-seven percent of the respondents felt that more frequent transit service to the shopping center would be a measure that would be likely to influence a decision to not drive. Other influential measures were: shopper's shuttle service (19.7 percent), shuttle service from the Caltrain or LRT rail station (21.5 percent) and bicycle-only lanes and storage areas (15.1 percent). Almost fourteen percent of the respondents indicated that none of the measures would be likely to influence their decision.

Parking Measures

Roughly half of the respondents (50.7 percent) indicated that they would shop elsewhere if a fee of $0.50 per hour was charged for parking. Many responded that they would make fewer trips (18.9 percent) and 21.8 percent would continue to drive regardless of the fee.

If the parking fee wasraised to $1.00 per hour, the percentage who would continue to drive dropped to eight percent, while more people indicated that they would shop elsewhere (sixty-two percent) or use another mode (9.8 percent).

Were the parking fee to be raised to $2.00 per hour, most of those surveyed chose strategies that would not minimize their trips by car, but chose other ways to avoid the parking fee. Many would chose to park outside the shopping center (15.9 percent), or, still by far the most popular option, shop elsewhere (69.6 percent). Fewer people chose to pay the fee but make fewer trips (2.2 percent) or use another mode (9.8 percent) to save on parking costs.

Case Study Site: SM

Demographic Characteristics

Key demographic characteristics for SM are illustrated in Figure 3-5. Approximately half of the survey respondents at SM were evenly distributed across the age groups from 25 to 54 years old. Relative to the other shopping centers, an unusually large number were in the 65 or older range (16.6 percent). Nine percent were in the 16 to 17 age range. The highest household income category included in the

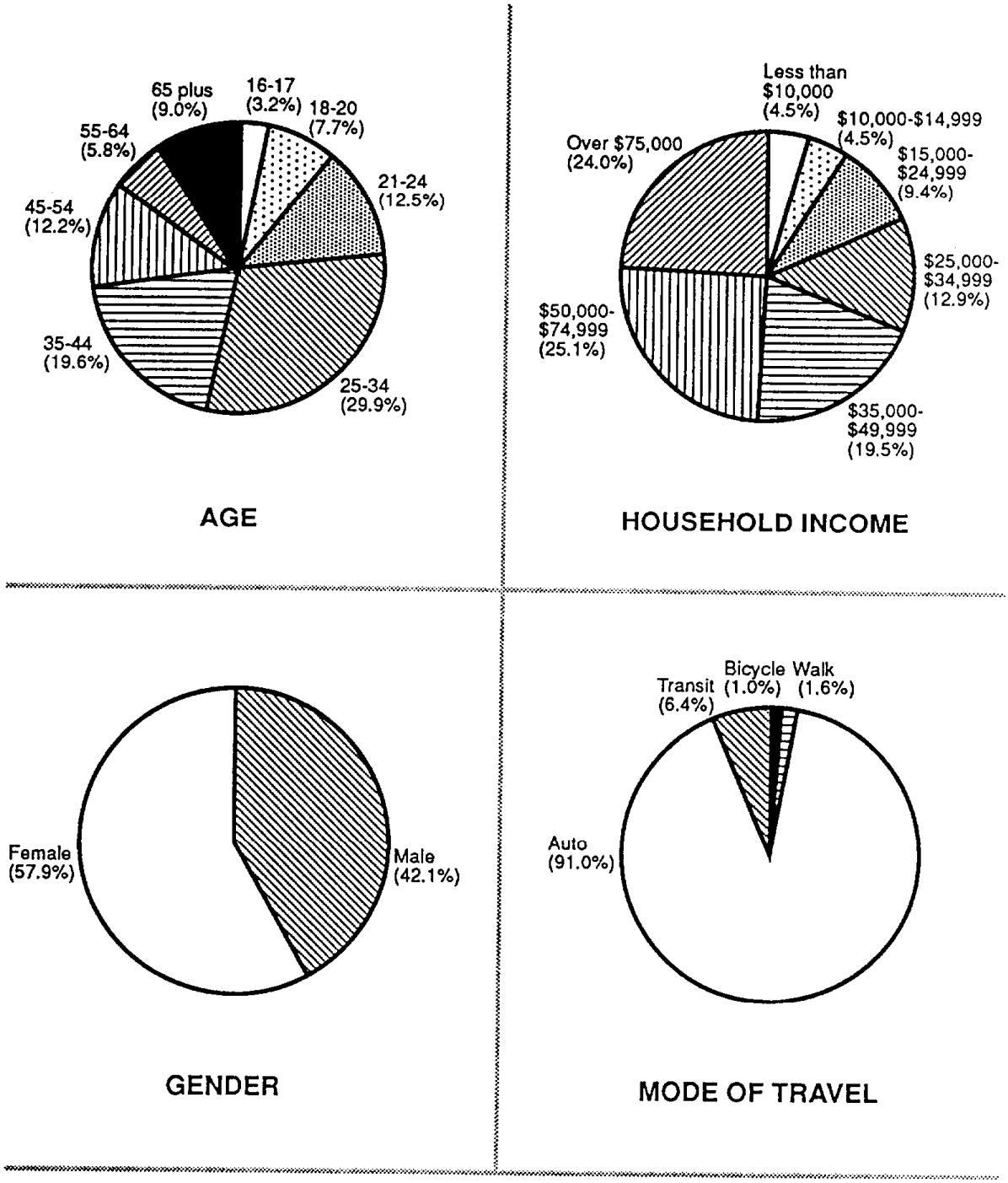


Figure 3-3
SL2: Selected Characteristics of Survey Respondents

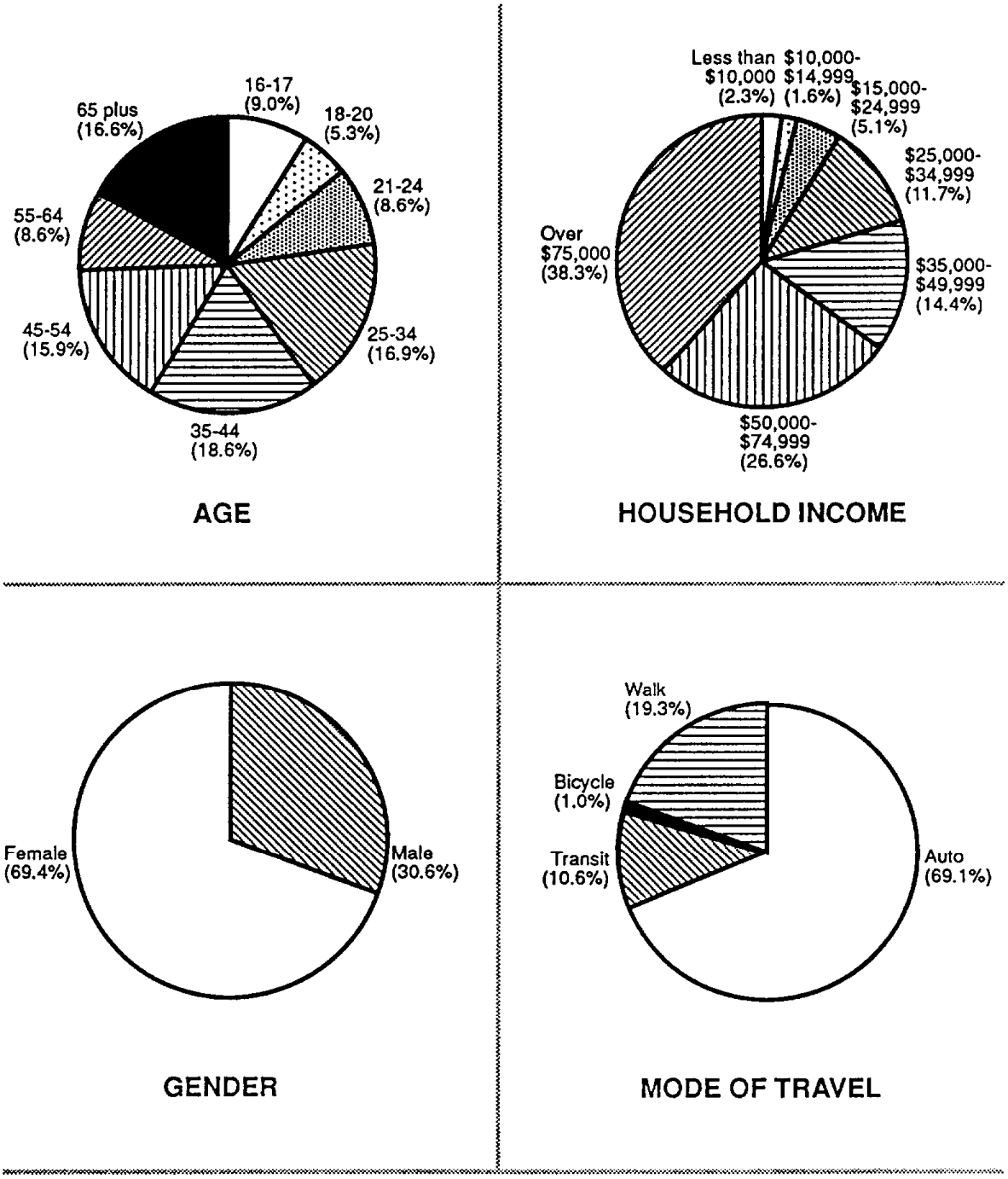


Figure 3-5
SM: Selected Characteristics of Survey Respondents

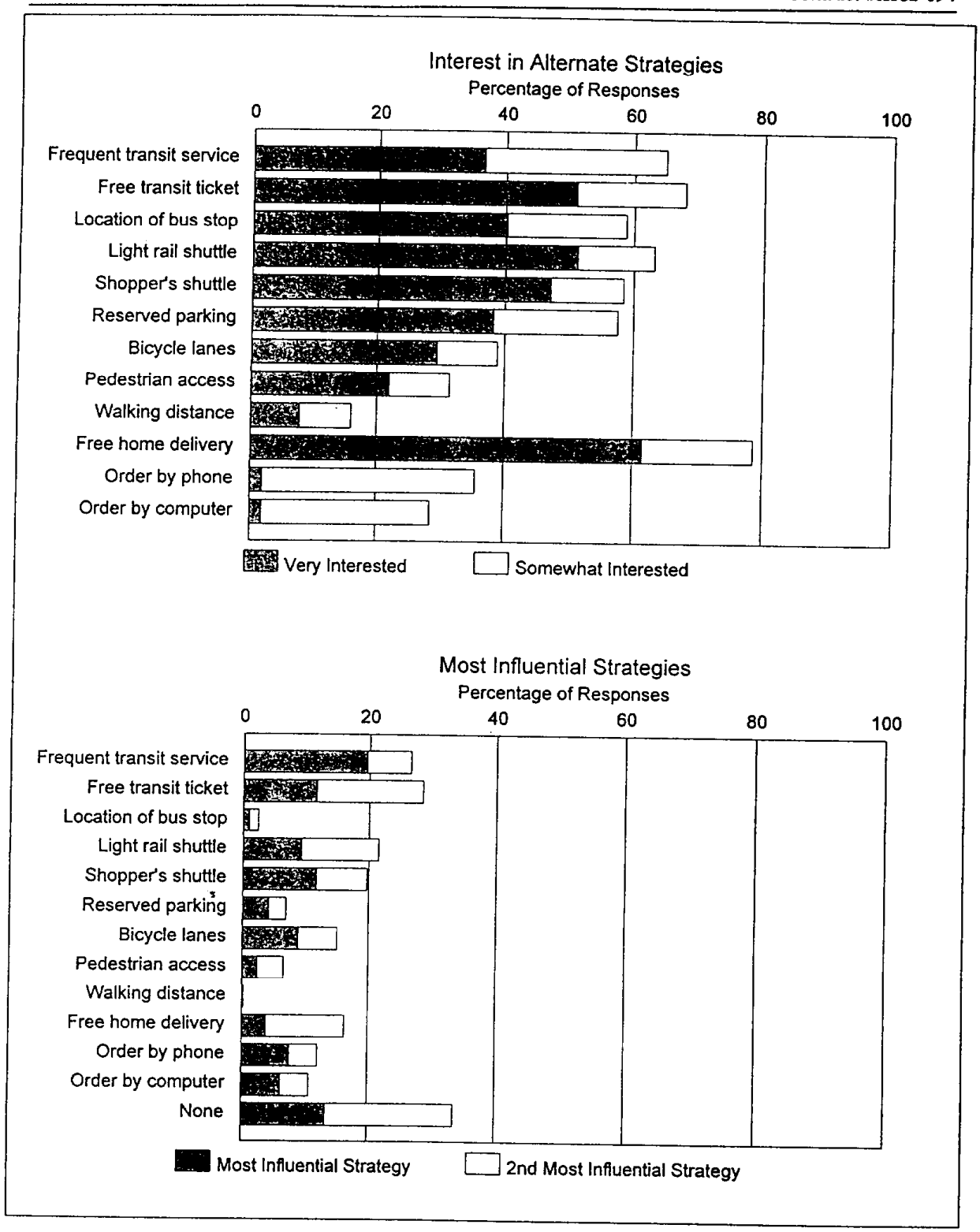


Figure 3-4
SL2: Response to Travel Reduction Measures

Travel Reduction Measures

A summary of responses to questions regarding level of interest in travel reduction measures is illusted in Figure 3-6. A free transit ticket was the travel reduction measure in which most respondents indicated some interest (66.8 percent). This measure is followed by a high level of interest in free home delivery (55.3 percent) and improved pedestrian amenities (51.2 percent).

Respondents indicated that the measures most likely to influence them to come to the shopping center by a mode other than by car were: free bus or rail ticket for making purchases (30.8 percent), free home delivery of packages (19.4 percent) and reserved parking for carpools (16.6 percent). Many of the respondents indicated that none of the measures would be likely to influence their decision (22.6 percent).

Parking Measures

Many of the respondents (39.9 percent) indicated that they would continue to drive to the shopping center if a fee of $0.50 per hour were charged for parking, some would make fewer trips (10.1 percent), and many would either shop elsewhere (20.2 percent) or park outside the shopping center (22.1 percent). If the fee were raised to $1.00 per hour, the percentage who would continue to drive drops to 11.6 percent, while more people indicated that they would park outside the garage (33.3 percent) or use another mode (11.6 percent). Were the parking fee to be raised to $2.00 per hour, most respondents will use some strategy to avoid paying the fee at all. Very few of those surveyed would continue to drive (4.8 percent) or use the strategy of making fewer trips (2.9 percent) to save on parking costs. The other respondents would choose either to park outside (37.8 percent), use another mode (12.0 percent) or shop elsewhere (42.6 percent).

Case Study Site: SH

Demographic Characteristics

Key demographic characteristics for SH are illustrated in Figure 3-7. Twenty percent of the repondents at SH were in the 25 to 34 age range. Only 9.7 percent were 65 or older and 14.0 percent were 20 or younger. Twenty percent had an annual houshold income between $35,000 and $49,999, and another 35 percent of the respondents had an annual income exceeding $50,000.

Slightly more women were interviewed than men, 56.4 percent and 43.6 percent respectively. Forty-seven percent of those surveyed are employed full time, 10.3 percent are retired, and 10 percent are homemakers.

Household Characteristics

The average number of residents per household was 2.9, with 27.3 percent of the respondents living in two person households. More than half of the respondents (64.7 percent) have no children under 18 living in their households, though almost twenty percent of households have at least one child under six (19.7 percent).

Twenty percent of those who responded had no employed adults in their household, but the overall average is 1.7 employed adults per household. Sixty-six percent of the households have one or two vehicles available.

survey, "over $75,000,"' contained the largest number of respondents, 32.7 percent. The median response was in the $35,000 to $49,999 annual income group.

Greater than two thirds of the respondents were women, representing 69.4 percent of those surveyed at this location. Full-time workers comprised 38.5 percent of this group, 16.9 percent were retired, and 13.6 percent are full-time homemakers.

Household Characteristics

The average number of people per household was 2.8, with two-person households representing 34.2 percent of the total. Sixty percent of the respondents have no children living in their households; forty percent have one or more children under 18, and 11.5 percent have one child under 6 in their households.

Many households contain two working adults (45.4 percent), though almost one-quarter reported no working adults in their household (22.7 percent). Despite this, 70.6 percent of the households have two or more vehicles, with an average of 2.36 vehicles per household. The majority of respondents work either full or part-time (56.8 percent), a large number are retired (16.9 percent), ten percent are full-time students, and 13.6 percent are homemakers.

Trip Characteristics

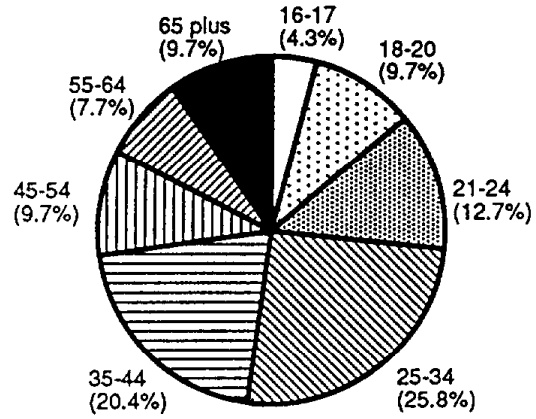
For the majority of respondents, shopping was the primary purpose of their trip (65.7 percent). Many respondents walked to this shopping center (19.3 percent), and the rest came by car (69.1 percent), bus or rail (10.6 percent) and bicycle (1.0 percent). Many of the respondents had come directly from home to the shopping center and would be returning directly home afterwards (35.9 percent).

Over sixty percent of the respondents traveled less than six miles to get to the shopping center, with a large number traveling 2 to 6 miles (35.5 percent). The trip took an average of 16.5 minutes, and less than fifteen minutes for 49.8 percent of the respondents. Most of those surveyed will spend an hour or more in the shopping center, with the average trip length of one and a half hours.

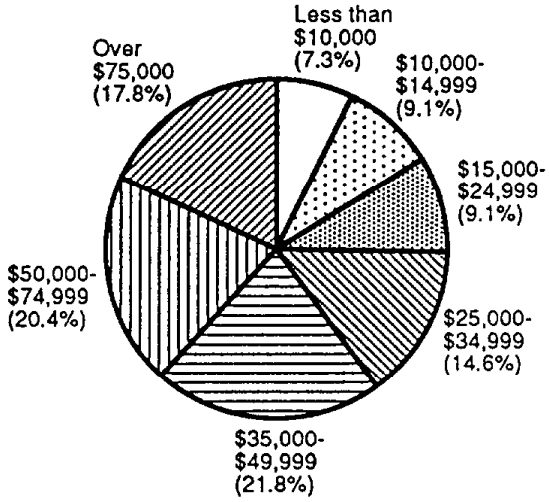
Only 6.8 percent of the people who came by car indicated that they expect to pay for parking, with five people responding with estimates averaging $0.57. Most people found parking without much trouble (65.9 percent), while 31.3 percent indicated that they had to look awhile or found it very difficult to locate parking.

Travel Alternatives

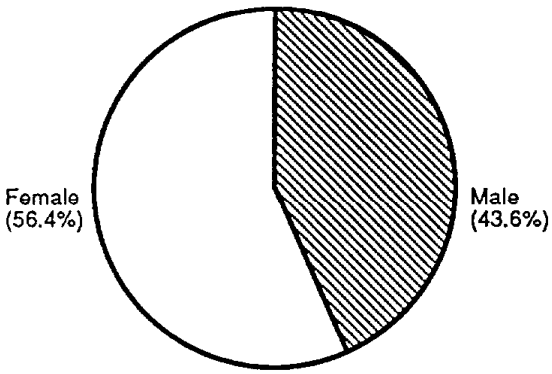
Approximately one third of the respondents traveled to the shopping center using a mode other than private vehicle (30.9 percent). Of those people, 40.4 percent had a car available for the trip and 62.8 percent have a driver's license. Of those who came by car, 51.4 percent knew of transit service available for their trip, 29.3 percent did not know if transit was available, and 19.2 percent were certain that transit was not an option for this trip. In addition to lack of access to transit, some common responses to a question about why transit was not used were: takes too long (21 responses), difficultly traveling with infants or large packages (16 responses) and lack of knowledge about transit system or schedules (9 responses).



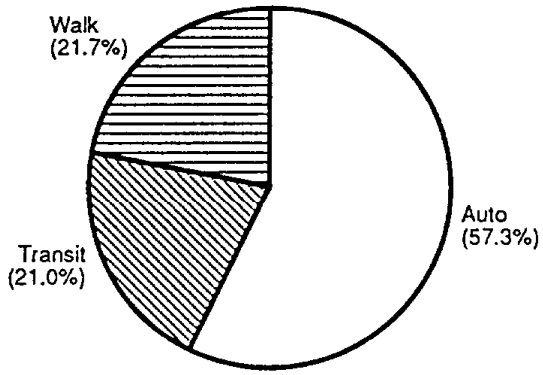
AGE



HOUSEHOLD INCOME



GENDER



MODE OF TRAVEL

Figure 3-7
SH: Selected Characteristics of Survey Respondents

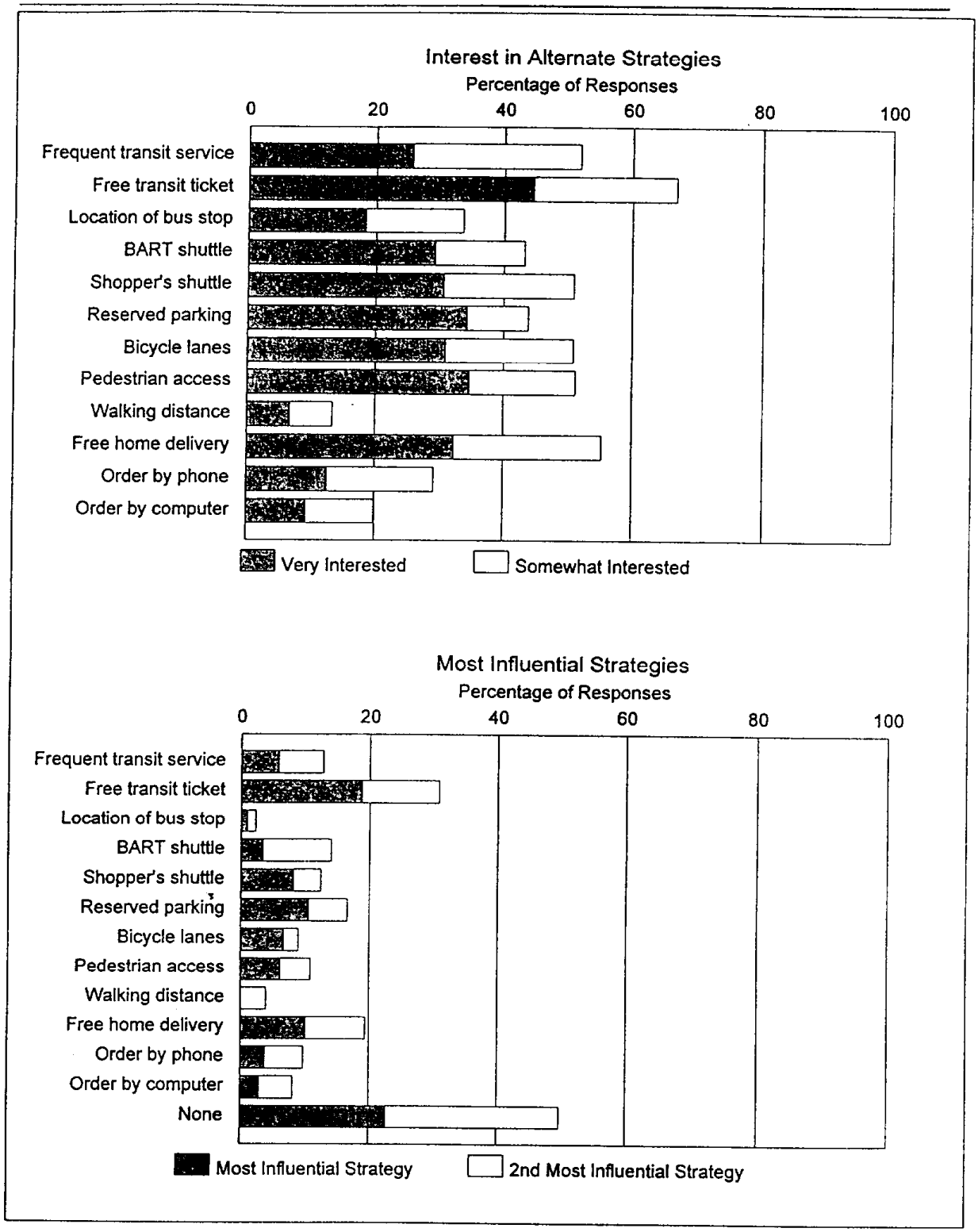


Figure 3-6
SM: Response to Travel Reduction Measures

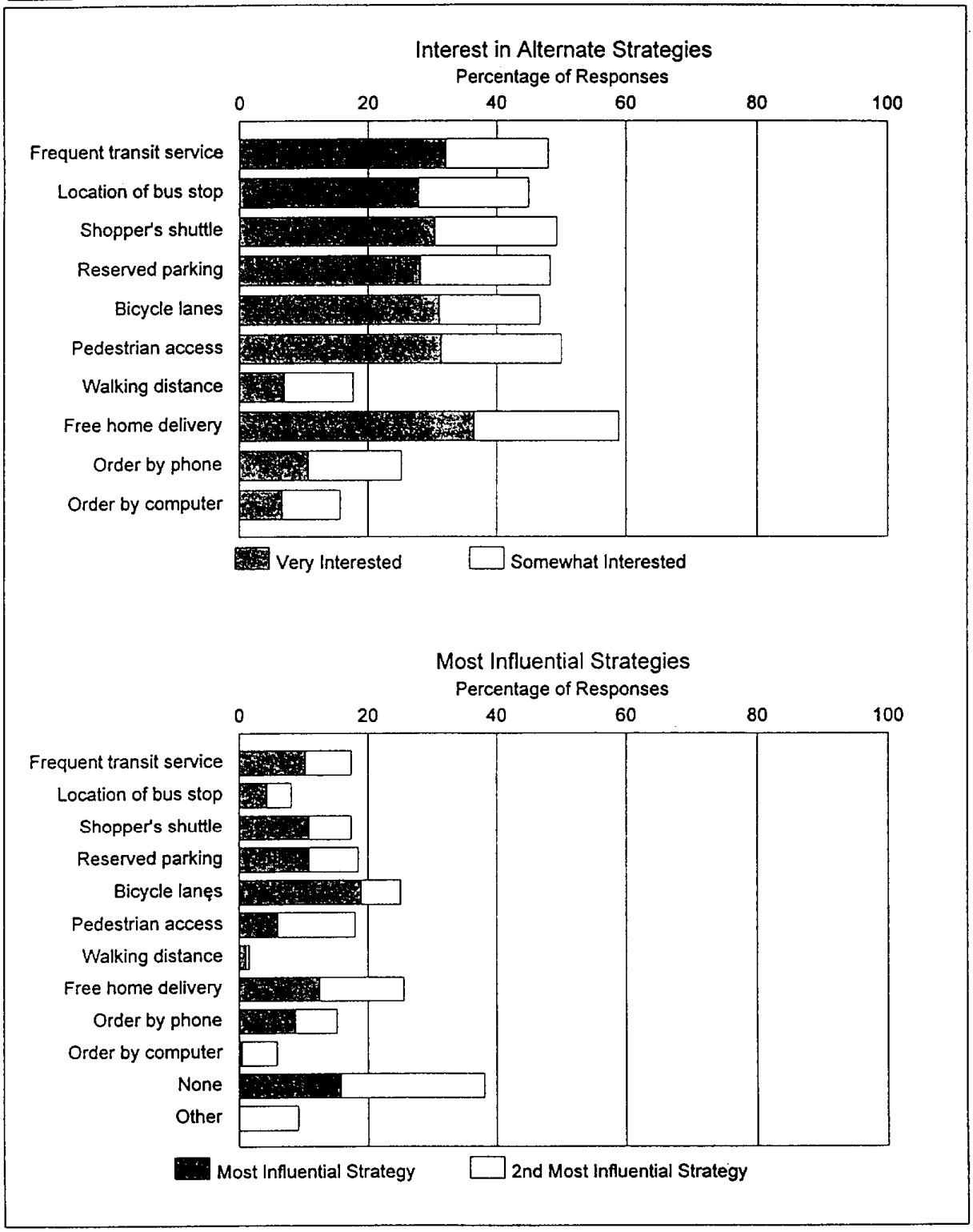


Figure 3-8
SH: Response to Travel Reduction Measures

Trip Characteristics

At SH, 56.7 percent of those surveyed were shopping as their primary purpose. Eating out and entertainment were the primary purpose for significant numbers of people at this shopping center in particular (17.3 and 8.7 percent, respectively). A large number of respondents traveled to this shopping center by walking (21.7 percent) and by bus (21.0 percent), and remainder came to the shopping center by private vehicle (57.3 percent).

Approximately, forty percent of the respondents traveled between 2 and 6 miles to get to the shopping center (39.7 percent), with an average trip length for all those surveyed of 19 minutes. The average length of time that respondents were planning to spend in the shopping center is one hour and 45 minutes, with more than half (52.7 percent) of those people planning to spend at least an hour and a half at SH. Most people who came by car to the shopping center do not expect to pay for parking, however among the 10 respondents who will pay, the estimated costs ranged from $0.25 to $3.00.

Travel Alternatives

Forty-three percent of the respondents came to the shopping center by a mode other than by auto; of these people, 35.4 percent did not have a car available for the trip and 56.9 percent have a driver's license. Of those who came by car, 59.9 percent knew of transit service available for their trip to SH, 30.2 percent did not know if transit was available, and 9.9 percent were certain that transit was not an option for this trip. In addition to lack of access to transit, some common responses to regarding why transit was not used were: takes too long (38 responses), safety concerns (28 responses), difficultly traveling with infants or large packages (15 responses) and lack of knowledge about transit system or schedules (13 responses).

Travel Reduction Measures

A summary of responses to questions regarding level of interest in travel reduction measures is illustrated in Figure 3-8. Free home delivery was the travel reduction measure in which most respondents indicated some positive interest (58.9 percent). This measure is followed by a high level of interest in pedestrian amenities (50.0 percent), a shopper's shuttle (49.3 percent) and reserved parking for carpools.

The measure likely to influence the most people to use an alternative mode to travel to this shopping center is increased bicycle amenities (25.0 percent) and the free home delivery measure (25.5 percent). Other influential measures were: reserved parking for carpools (18.5 percent) and improved pedestrian amenities (18.0 percent). Many of the respondents indicated that none of the measures would be most likely to influence their decision (15.8 percent).

Parking Measures

One quarter of the respondents (25.8 percent) indicated that they would continue to drive to the shopping center even if a fee of $0.50 per hour was charged for parking. Approximately one third of the respondents would shop elsewhere (30.5 percent), 16.7 percent would park outside the shopping center parking area, while some would chose another mode (12.6 percent). If the fee were raised to $1.00 per hour, the percentage who would continue to drive drops to 8.4 percent, while more people indicated that they would park outside (22.8 percent) and just a few more would use another mode (15.0 percent). When the parking fee is raised to $2.00 per hour, would now shop elsewhere (54.2 percent), while many continue to park outside (23 percent), and just a few more people decide to switch to a different mode (16.7 percent).

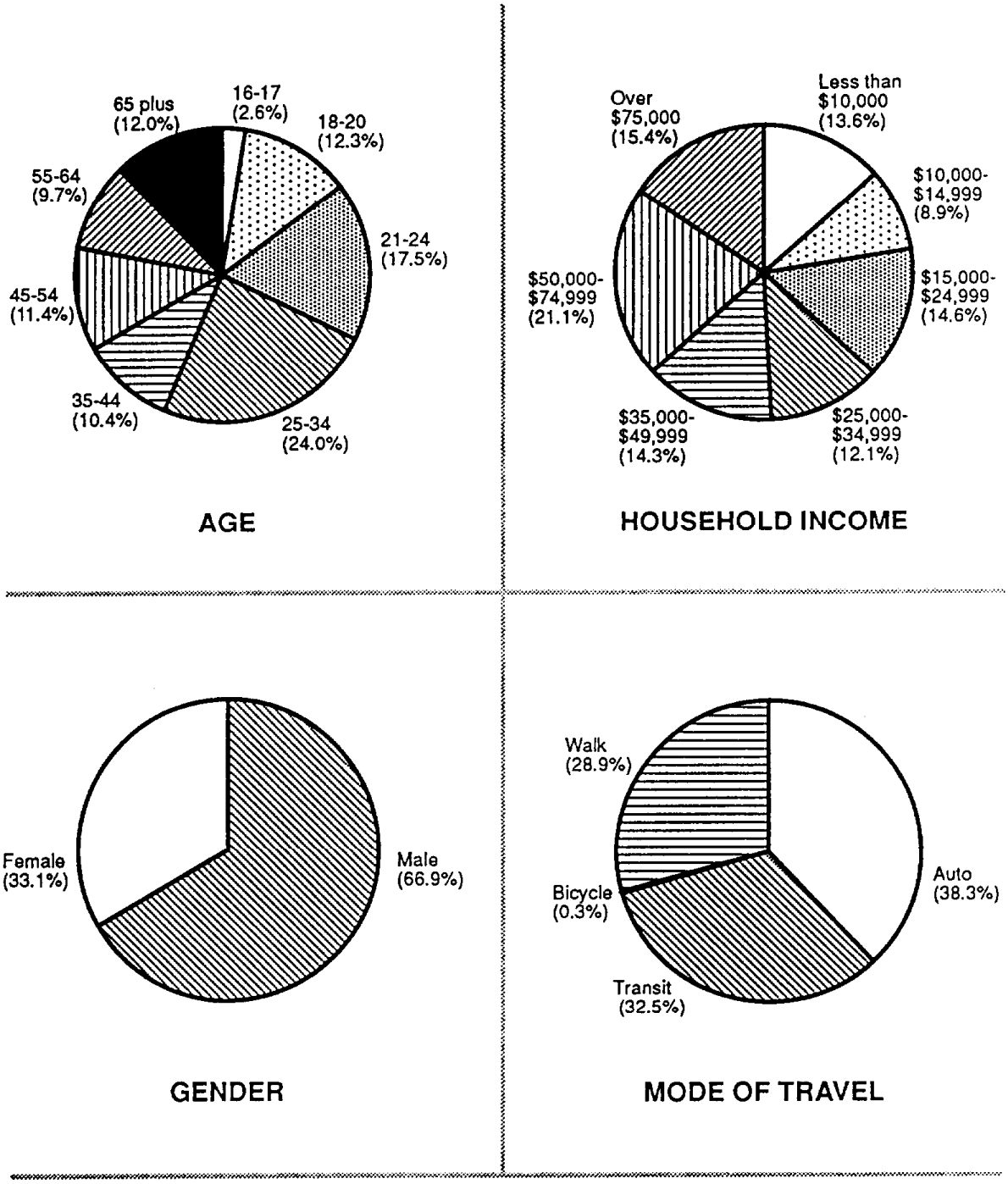


Figure 3-9
UH: Selected Characteristics of Survey Respondents

Case Study Site: UH

Demographic Characteristics

Key demographic characteristics for UH are illustrated in Figure 3-9. Half of the UH respondents are younger than 35 years old. The income range with the largest number of respondents is $50,000 to $74,999 (19.2 percent), and the smallest number of respondents is in the $10,000 to $14,999 income range. An number of respondents have annual household incomes of less than $10,000 (12.3 percent).

Two thirds of the respondents at UH were men, respresenting 66.9 percent of the total. Fifty-four percent of those surveyed were employed full time, 6.5 percent were full time students, 11.7 percent were retires and 1.9 percent are full-time homemakers.

Household Characteristics

The average number of people per household was 2.7, with the median response in the two person household category. About thirty percent of the respondents have children under 18 living in their households, and approximately half of those people also have children under 6 in their households (46.7 percent).

The average number of employed adults per household is 1.6. None of the households had more than two employed adults, however, 23.8 percent of the total survey respondents did not provide an answer to this question. Twenty percent of the households have no vehicles. The overall average number of vehicles per household is 1.8, and the median response is three vehicles per household.

Trip Characteristics

The most common purpose for the trip to the shopping center was for shopping (39.9 percent), followed by "eating out" and entertainment (17.5 and 12.3 percent, respectively). Less than half of the respondents traveled to the shopping center by car (35.7 percent), with an average of 1.9 persons per vehicle. One quarter of the respondents came by bus (23.4), and 28.9 percent came to the shopping center on foot.

One quarter of the respondents travelled less than half a mile to UH, 37.4 percent travelled from half a mile to 6 miles, and the remaining 37.9 percent came from over 6 miles away to get to the shopping center. Respondents were planning to spend an average of slightly over two hours (126.7 minutes) at the shopping center. Of the people who came to the shopping center by car, 26.1 percent responded that they expect to pay an average of $2.82 for parking.

Travel Alternatives

Sixty-four percent of the respondents came to the shopping center by a mode other than by private vehicle, 34.5 percent of those people had a car available for the trip and sixty-four percent have a driver's license. Of those who came by car, 48.2 percent knew of transit service available for their trip to the shopping center, 23.6 percent did not know if transit was available, and 28.2 percent were certain that transit was not an option for this trip.

Travel Reduction Measures

A summary of responses to questions regarding level of interest in travel reduction measures is illustrated in Figure 3-10. Over eighty percent of respondents indicated some interest in the free transit ticket travel reduction measure. Respondents were also interested in improved pedestrian access, free home delivery and more frequent transit service.

Despite the high level of interest displayed in some of the measures, respondents indicated that most of the measures were unlikely to influence their decision to come to the shopping center by car. A free bus or light rail ticket for making purchases was the travel reduction measure cited by the most respondents as likely to influence decision not to drive to the shopping center (33 percent); more frequent transit service and free home delivery were likely to influence 15 and 18 percent of respondents, respectively. Sixty-one percent of the respondents indicated that none of the measures would be likely to influence their decision.

Parking Measures

Almost half of the respondents (48.6 percent) indicated that they would continue to drive if a fee of $0.50 per hour was charged for parking. The majority of the rest would park outside the shopping center (18.9 percent) or or shop elsewhere (17.1 percent).

If the parking fee were raised to $1.00 per hour, the percentage who would continue to drive dropped to 23.1 percent, while more people indicated that they would park outside (27.8 percent) or shop elsewhere (30.6 percent).

If the fee were raised to $2.00 per hour, 18 percent of respondents would choose to use another mode to get to the shopping center. Only five percent of the respondents would continue to drive, and only three percent would make fewer trips to avoid the parking fee.

Selected Data Comparisons

The modal share data reflects the unique characteristics of each of the 5 shopping centers. SL1 and SL2 have very low transit, bicycle or walking percentages; in both cases the number arriving by car exceed 90 percent and those travelling on transit is four and six percent, respectively. Nineteen percent of the respondents at SM walked to get there, and 11 percent came by bus. At SH, the transit ridership was up to 21 percent of the respondents, with 22 percent walking. At UH, only 38 percent of the respondents had come by car, 32 percent by transit and 29 percent walked to the center.

Overall, two-thirds of those who travelled to the shopping centers by transit, bike or walking had no car available for the trip. For approximately one half of all the shoppers who drove to the shopping centers, some form of transit was available. The median trip length for all the shopping centers was in the two to six mile range, except at SL1, where the median distance travelled was in the six to ten mile range.

At all the shopping centers, the majority of respondents indicated little or no difficulty finding parking, and most did not expect to pay for parking. At three shopping centers respondents were expecting to pay from an average of $0.57 for parking at SM, up to an average of $2.82 at UH.

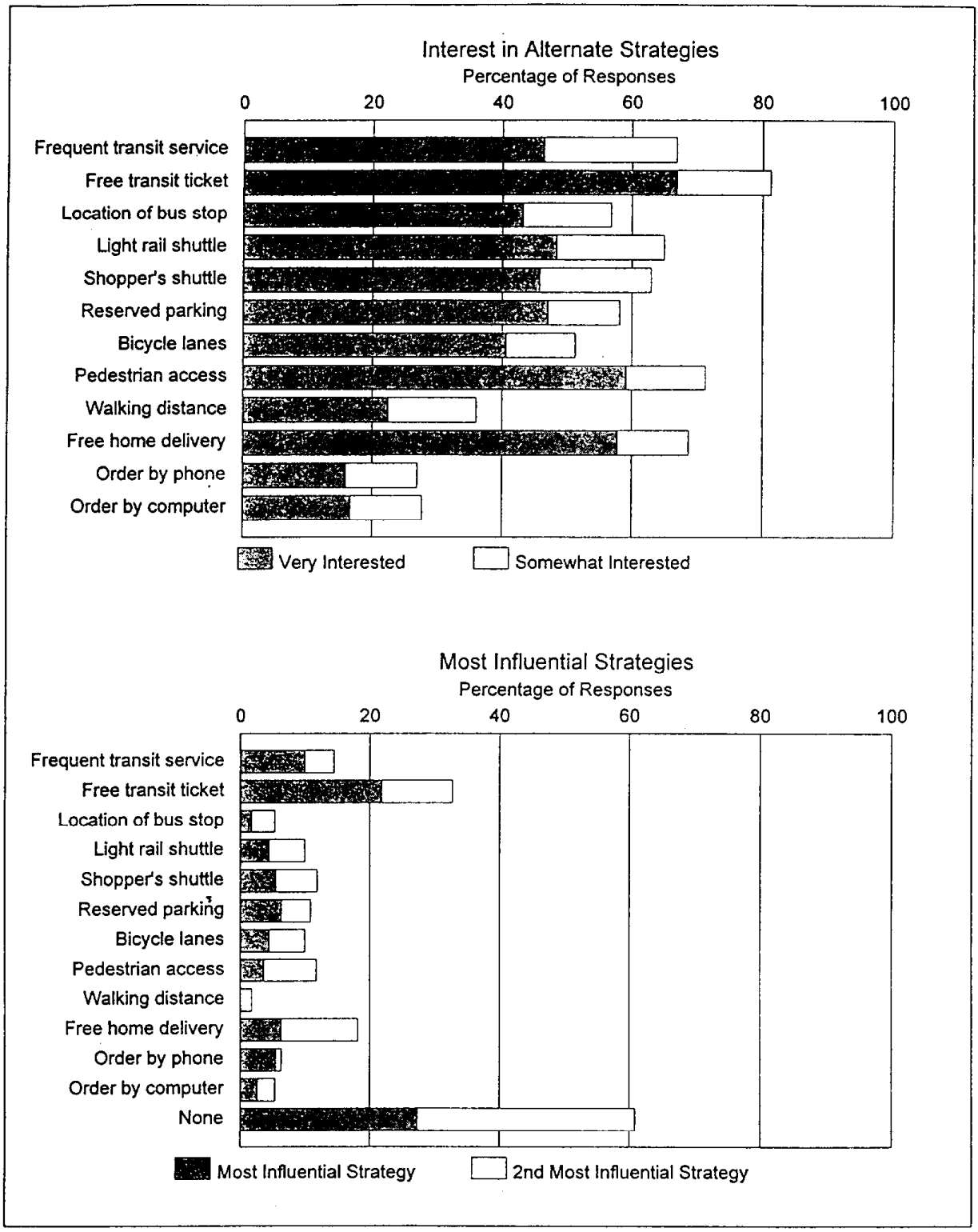


Figure 3-10
UH: Response to Travel Reduction Measures

4.0 EVALUATION OF TRAVEL BEHAVIOR AT CASE STUDY SITES

This chapter explores mode of travel to/from shopping centers and reasons for differences in modal shares. Understanding reasons for differences in the proportion of auto users, transit users, cyclists, and walkers is important for the study, because it will facilitate the identification of which land uses and transportation strategies may be most or least likely to influence auto use.

The data collected at each of the case study sites provide a description of the characteristics of both the regional shopping center and of the travel behavior of the individuals who make use of the shopping center. As indicated in Table 4-1, there are noticeable differences between case study sites in the distribution of travel modes. While SL1 has by far the highest auto use (95.0 percent), a good deal of the people that arrive by car are not in single-occupant vehicles. UH has the highest transit and walk mode shares and the lowest drive-alone percentage. Only about one-third of those traveling to UH arrive by auto. Both SM and SH have high walk mode shares; almost one out of five persons walks to the center. The highest drive-alone mode share occurs at SL2, which also has the second lowest transit and walk shares. There was little, if any, bicycle use at any of the case study sites.

In this chapter, possible reasons for these differences will be explored, including:

- differences in demographics among the regional shopping centers;
- differences in travel patterns or trip purposes; and
- the site characteristics of the regional shopping center itself.

In examining factors that might explain the mode of travel, driving alone and carpooling were combined into a single category to represent auto use.

4.1 DEMOGRAPHICS

Many studies suggest that there are differences in the use of alternative transportation modes between various demographic groups. To determine whether this was an explanation for the differences in mode share between the case study sites, the mode share was examined by age, gender, household income, and number of people in the household. This demographic information was obtained during the shopper survey. A summary of this comparison is provided in Tables 4-2a and 4-2b.

At three of the shopping centers, the number of male and female respondents are close to equal. At SM, the women respondents outnumber the men by almost 2 to 1, whereas the opposite is true at UH, where 67 percent of those surveyed were men.

The median respondent across all the shopping centers was in the 25 to 34 age range, and at all of the shopping centers except SM, at least half of the respondents worked full-time. The median response for annual income was in the $35,000 to $49,000 range, except at SM, where the median income was in the next higher income bracket, $50,000 to $74,000.

(4070/CHAP3.FIN)

Table 4-2a
Mode Share by Demographic Characteristics and Shopping Center
(Percent)

		GENDER		AGE							
		Male	Female	16 to 17	18 to 20	21 to 24	25 to 34	35 to 44	45 to 54	55 to 64	65+
SL1	SL1										
SL1	SL1										
Auto	Auto	96.5	93.7	84.4	88.0	97.5	98.8	94.4	97.1	100.0	96.1
Transit	Transit	3.5	5.0	15.6	4.0	2.5	1.2	5.6	2.9	0.0	0.0
Walk	Walk	0.0	1.3	0.0	8.0	0.0	0.0	0.0	0.0	0.0	3.9
SL2	SL2										
Auto	Auto	88.5	92.7	60.0	87.5	82.0	95.7	96.7	97.4	100.0	75.0
Transit	Transit	9.2	4.5	20.0	12.5	12.8	4.3	3.3	2.6	0.0	10.7
Bicycle	Bicycle	1.5	0.6	20.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0
Walk	Walk	0.8	2.2	0.0	0.0	2.6	0.0	0.0	0.0	0.0	14.3
SM	SM										
Auto	Auto	53.3	76.1	43.7	65.4	66.7	85.7	79.2	80.8	62.0	100.0
Transit	Transit	10.8	10.5	37.5	19.2	13.7	5.4	6.2	3.8	6.0	0.0
Bicycle	Bicycle	2.2	0.5	0.0	3.9	4.0	0.0	0.0	0.0	0.0	0.0
Walk	Walk	33.7	12.9	18.8	11.5	15.6	8.9	14.6	15.4	32.0	0.0
SH	SH										
Auto	Auto	54.6	58.9	23.1	48.3	47.4	68.8	62.3	65.5	56.5	44.8
Transit	Transit	18.5	23.2	23.1	44.8	31.6	11.7	13.1	20.7	17.4	27.6
Walk	Walk	26.9	17.9	53.5	6.9	21.0	19.5	24.6	13.8	26.1	27.6
UH	UH										
Auto	Auto	36.9	41.1	0.0	47.4	51.9	48.7	34.4	40.0	23.4	10.8
Transit	Transit	32.5	32.4	62.5	42.1	35.2	21.6	15.6	20.0	43.3	51.4
Bicycle	Bicycle	0.0	1.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0
Walk	Walk	30.6	25.5	37.5	10.5	11.1	29.7	50.0	40.0	33.3	37.8

(4070/TB4-2FIN.WK3) *(4070/TB4-2FIN.WK3)*

Table 4-1
MODE SHARE BY CASE STUDY

	SL1	SL2	SM	SH	UH
Percent of all trips that are:					
Auto	95.0	91.0	69.1	57.3	38.3
Drive alone	*18.3*	*46.2*	*36.2*	*26.0*	*16.2*
2 people	*39.0*	*33.3*	*24.9*	*22.0*	*14.3*
3+ people	*37.7*	*11.5*	*8.0*	*9.3*	*7.8*
Transit	4.3	6.4	10.6	21.0	32.5
Bicycle	0.0	1.0	1.0	0.0	0.3
Walk	0.7	1.6	19.3	21.7	28.9
Total	100.0	100.0	100.0	100.0	100.0

(4070/TBL4-1.FIN)

The main finding after examining these data is that the proportion of transit and walk users increases with the level of transit service and with the proximity of the centers to dense office and residential land uses, largely irrespective of demographics. To illustrate this point, the proportion of transit use at each center, stratified by age and gender, is provided in Figures 4-1 and 4-2, respectively. The order in which the centers appear in the Figures reflects a continuum of the density of the areas surrounding the centers: the centers at the left (SL1 and SL2) are located in low density suburban surroundings; the centers in the middle (SM and SH) are located in suburban medium and high density areas with increasing transit service; and the center at the right (UH) is located in an urban area surrounded by dense office and residential development and is linked to an extensive, regional transit system. A very powerful and consistent result emerges from the charts: regardless of age or gender, transit use increases from the left to the right of each figure as transit service and proximity to dense office and residential uses increases.

Conversely, overall auto use is generally higher for the centers that have less transit service and less dense surrounding land uses than for centers with more transit service and higher surrounding densities, even though the more transit intensive centers have less carpooling than the centers with less transit. (See Table 4-1). The decline in carpooling at the transit intensive centers is probably the result of overlapping transit and rideshare markets. As the literature review suggests, it is not unusual for expanded transit to draw from carpoolers. Apparently, rideshare and transit patrons share some common preferences for use of high occupancy modes and will switch between these modes depending on changes in service levels, fares or other variables. Consequently, reduced carpooling might be expected where higher transit use is present.

4.2 TRAVEL PATTERNS AND TRIP PURPOSE

The characteristics of the trip itself may also influence mode choice. Significant variations of trip characteristics among the case study sites may help to explain the large difference in mode shares for the centers.

One trip characteristic examined was travel pattern. For this study, travel pattern was defined as the combination of the origin from which an individual was traveling prior to arriving at the shopping center, and the destination to which the individual will travel after leaving the shopping center. This

Table 4-2b
Mode Share by Demographic Characteristics and Shopping Center
(Percent)

	INCOME							NUMBER IN HOUSEHOLD					
	under $10,000	$10,000 to $14,999	$15,000 to $24,999	$25,000 to $34,999	$35,000 to $49,999	$50,000 to $74,999	over $75,000	1	2	3	4	5	6+
SL1													
SL1													
Auto	57.1	80.9	95.2	94.7	98.4	97.0	100.0	91.3	97.9	95.1	97.1	91.2	83.3
Transit	42.9	14.3	2.4	5.3	1.6	3.0	0.0	8.7	2.1	3.3	1.5	8.8	16.7
Walk	0.0	4.8	2.4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.4	0.0	0.0
SL2													
Auto	76.9	46.2	85.2	94.6	87.5	98.6	100.0	83.3	94.6	91.5	87.8	95.6	84.2
Transit	23.1	46.2	7.4	2.7	10.7	0.0	0.0	12.5	1.8	8.5	9.2	0.0	15.8
Bicycle	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.9	0.0	1.5	4.4	0.0
Walk	0.0	7.6	7.4	2.7	1.8	0.0	0.0	4.2	2.7	0.0	1.5	0.0	0.0
SM													
Auto	50.0	25.0	30.8	63.3	64.9	69.1	79.6	55.8	72.8	71.2	72.6	68.8	54.5
Transit	33.3	25.0	30.8	16.7	10.8	8.9	4.1	7.0	5.8	16.7	9.7	25.0	18.2
Bicycle	0.0	0.0	0.0	0.0	2.7	2.9	0.0	0.0	2.9	0.0	0.0	0.0	0.0
Walk	16.7	50.0	38.4	20.0	21.6	19.1	16.3	37.2	18.5	12.1	17.7	6.2	27.3
SH													
Auto	55.0	48.0	40.0	35.0	65.0	62.5	67.3	53.8	61.0	58.6	59.2	60.6	30.8
Transit	20.0	44.0	36.0	25.0	15.0	17.9	14.3	15.4	13.4	27.6	20.4	24.2	61.5
Walk	25.0	8.0	24.0	40.0	20.0	19.6	18.4	30.8	25.6	13.8	20.4	15.2	7.7
UH													
Auto	18.4	24.0	31.7	44.1	45.0	44.1	46.5	26.0	50.5	29.8	52.0	38.9	18.2
Transit	47.4	52.0	51.2	29.4	25.0	18.6	18.6	39.7	22.0	25.5	20.0	44.4	63.6
Bicycle	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0
Walk	34.2	24.0	17.1	26.5	27.5	37.3	34.9	34.3	27.5	44.7	28.0	11.1	18.2

(4070/TB4-2FIN.WK3)

information was obtained from the shopper survey. The major categories used in the analysis are listed below and include trips in both directions.

- Home-Shopping Center-Home (H-SC-H)
- Home-Shopping Center-Work (H-SC-W)
- Work-Shopping Center-Work (W-SC-W)
- Home-Shopping Center-Shopping (H-SC-S)
- Home-Shopping Center-Other (H-SC-O)
- Other

Trip patterns may influence mode choice. For example, people may be more amenable to use transit for H-SC-H trips than for other types of trips. Similarly, people may be more likely to walk or bicycle for W-SC-W trips, depending on the proximity of the shopping center to work. Mode share by travel pattern for each of the case study sites is illustrated in Table 4-3. It appears that those persons with W-SC-W travel patterns are the most likely to walk and the least likely to use transit. In four of the five centers, the highest walk percent is for the H-SC-W trip. Those shopping centers with higher walk proportions do have a higher proportion of W-SC-W trips. However, the relatively high walk shares cannot be explained by the variation in W-SC-W trips. The variation in walk shares is far greater than the smaller variation in W-SC-W trips. In fact, the proportion of walk trips at SH and UH for all types of travel patterns is higher than at the other centers. In short, higher walk shares cannot be explained by variation in travel patterns across the centers.

A similar argument applies to transit use. While transit use tends to be highest for H-SC-H or H-SC-O trips patterns, the variation in these travel patterns across centers do not explain the variation in transit use. In fact, where transit use is high (SH and UH), H-SC-H and H-SC-O tend to be low-to-average in occurrence. In short, transit use also is not explained by the variation in travel patterns.

Another travel characteristic examined to determine its possible impact on mode share was trip purpose. In the shopper survey, a number of trip purposes were identified as being the determinants of mode choice to/from a center. A summary of the mode share by trip purpose for each case study site is provided in Table 4-4. While the use of an automobile tends to be higher among shopping trips than other trip purposes, a strong pattern between trip purpose and mode of travel is not obvious from the data. Therefore, the differences in trip purpose among the case study sites does not appear to explain mode share differences at the centers.

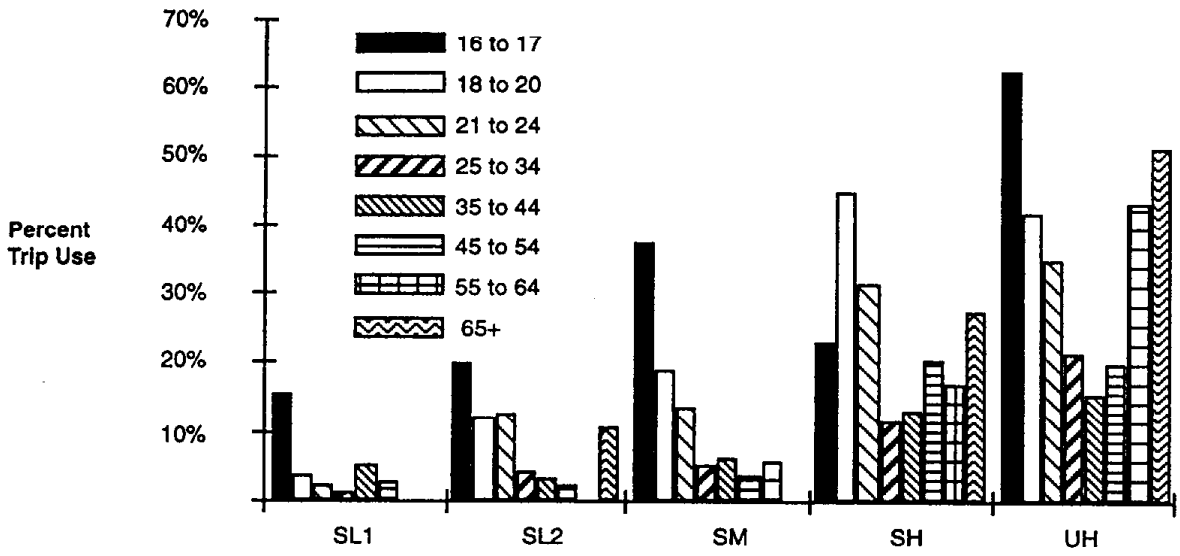


Figure 4-1
Transit Use by Age for Case Study Sites

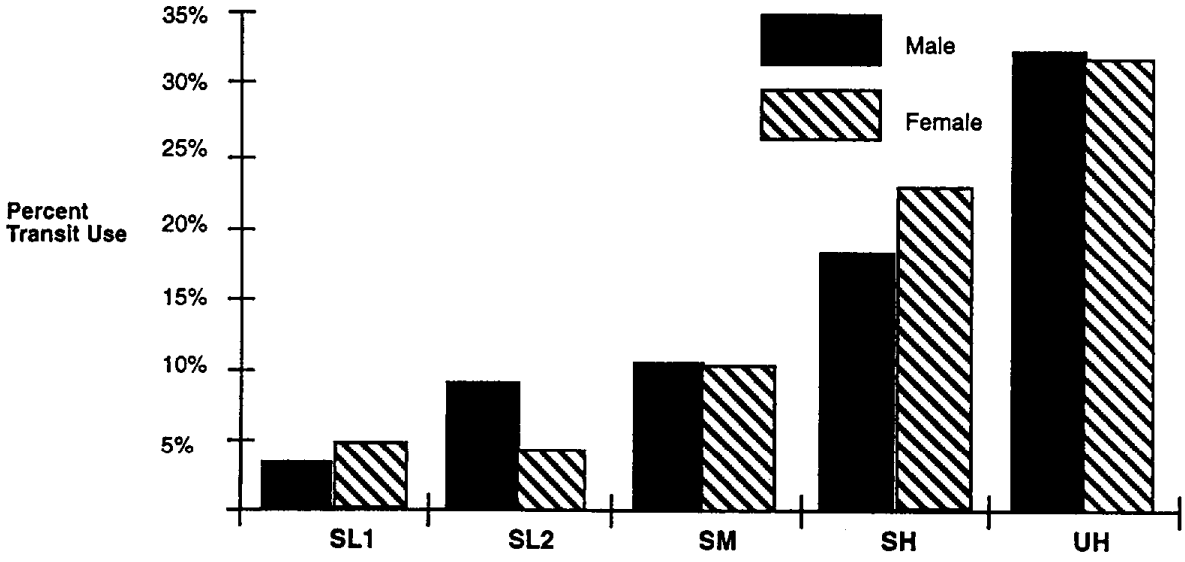


Figure 4-2
Transit Use by Gender for Case Study Sites

Table 4-4
MODE SHARE BY TRIP PURPOSE AND SHOPPING CENTER
(Percent)

	Shopping	Eating-Out	Entertainment	Personal Errands	Business Errands	Socializing	Other
SL1							
Auto	97.7	92.3	90.0	92.6	71.4	75.0	100.0
Transit	2.3	0.0	10.0	7.4	28.6	18.8	0.0
Walk	0.0	7.7	0.0	0.0	0.0	6.2	0.0
SL2							
Auto	91.3	80.0	80.0	96.6	100.0	87.5	77.8
Transit	6.5	0.0	20.0	3.4	0.0	12.5	11.1
Bicycle	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Walk	0.9	20.0	0.0	0.0	0.0	0.0	11.1
SM							
Auto	78.7	55.3	50.0	50.0	77.8	66.7	17.7
Transit	12.7	4.3	0.0	20.0	11.1	0.0	0.0
Bicycle	0.5	4.3	0.0	0.0	0.0	0.0	0.0
Walk	8.1	36.1	50.0	30.0	11.1	33.3	82.3
SH							
Auto	67.1	34.6	50.0	61.1	71.4	50.0	33.3
Transit	20.0	19.2	23.1	22.2	28.6	33.3	20.0
Walk	12.4	46.2	26.9	16.7	0.0	16.7	46.7
UH							
Auto	57.7	16.7	18.4	50.0	44.4	40.9	25.9
Transit	30.9	22.2	47.4	0.0	33.4	27.3	42.6
Bicycle	0.0	0.0	0.0	12.5	0.0	0.0	0.0
Walk	11.4	61.1	34.2	37.5	22.2	31.8	31.5

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Table 4-3
MODE SHARE BY TRAVEL PATTERN AND SHOPPING CENTER
(Percent)

	Travel Pattern					
	H-SC-H	W-SC-W	H-SC-W	H-SC-S	H-SC-O	OTHER
SL1						
Auto	95.4	100.0	91.3	95.7	93.7	96.1
Transit	3.1	0.0	8.7	4.3	6.3	3.9
Walk	1.5	0.0	0.0	0.0	0.0	0.0
SL2						
Auto	87.0	90.0	97.4	92.5	86.2	100.0
Transit	8.3	0.0	2.6	7.5	10.3	0.0
Bicycle	0.9	0.0	0.0	0.0	3.5	0.0
Walk	3.7	10.0	0.0	0.0	0.0	0.0
SM						
Auto	65.7	56.5	66.7	82.1	68.2	82.4
Transit	11.1	0.0	23.8	3.6	9.1	5.9
Bicycle	0.0	0.0	2.4	3.6	1.5	2.9
Walk	23.2	43.5	7.1	10.7	21.2	8.8
SH						
Auto	61.0	27.3	54.2	76.7	51.9	54.8
Transit	23.2	0.0	20.8	16.3	29.6	21.0
Walk	15.8	72.7	25.0	7.0	18.5	24.2
UH						
Auto	34.5	6.9	41.9	45.0	39.4	50.0
Transit	40.5	6.9	38.7	40.0	39.3	23.2
Bicycle	1.2	0.0	0.0	0.0	0.0	0.0
Walk	23.8	86.2	19.4	15.0	21.3	26.8

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Table 4-5
CASE STUDY SITE CHARACTERISTICS

	SL1	SL2	SM	SH	UH
Location	Suburban	Suburban	Suburban	Suburban	CBD
Density of Surrounding Land Uses	Low	Low	Medium	High	High
Freeway Accessibility	Immediately adjacent	Immediately adjacent	One mile	Immediately adjacent	Two miles
Cost for Parking*	None	None	$0.03	$0.10	$0.26
Transit Service					
Routes	6 bus routes	4 bus routes	3 bus routes Shuttle to rail	11 bus routes	31 bus routes 3 light rail lines
Headways (minutes)	2 routes: peak: 30 off-peak: 60 4 routes: peak: 15-60 off-peak: 30-60	2 routes: 30 2 routes: peak: 15 off-peak: 30	bus routes: peak: 15-60 off-peak: 30-60 shuttle: 20	5 routes: peak: 5-40 off-peak: 12-30 6 routes: peak: 10-30 off-peak: 10-60	bus routes: peak: 6-30 off-peak: 30-60 Light rail: 15-30
Location of transit stop	2 routes: 50 ft from center 4 routes: 250 ft from center	On-site, covered shelter stop	On-site	Border of shopping center, 4 routes across street	23 bus routes: major transfer point All: border of shopping center
Bicycle Amenities	No bike lanes on arterials Bike trail 2 miles south	Two bicycle racks for 20 bicyles	None	Class III bicycle lanes adjacent to center and one block away. 99 bicycle parking spaces in parking structure.	Bicycle racks at trolley station
Pedestrian Amenities	Few dedicated walkways	Sidewalks from bus stop and on residential side of center	Sidewalks to adjoining areas	Sidewalks and crosswalks to all adjoining areas.	Sidewalks to adjoining areas

* Average over all vehicles per trip (includes validation)

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4.3 CASE STUDY SITE CHARACTERISTICS

Overall, it appears that demographics, travel patterns, and trip purposes do not explain the variation in mode choice and auto use among the case study sites. Other case study site characteristics will be examined in this section.

In Chapter 3 of this report, characteristics of each of the case study sites were described, including surrounding land uses, accessibility to transit, quality and frequency of transit service, and accessibility to bicyclists and pedestrians. A summary of these characteristics is provided in Table 4-5. In comparing the variation of characteristics among the case study sites to the mode share at each site (Table 4-1), some patterns do emerge. Each alternative transportation mode was examined, and the patterns are summarized below.

- *Transit* - The percent of travel by transit increases with the provision of more transit routes and greater frequency of service. UH, which has a transit share of almost one-third, is located in an urban CBD with frequent, high-quality regional transit service. Provision of frequent transit service may also influence the likelihood of individuals to use transit to travel to a regional shopping center if they are familiar with transit and use it for other trip purposes, such as traveling to work. The proportion of transit use at the other case study sites also appears to vary with transit coverage and service intensity.

- *Bicycling* - There were too few observations to determine any pattern.

- *Walking* - The walking mode split increases as more office and residential development in the immediate area increases. Walk shares are higher at SH and UH, which have relatively more office and residential uses in the vicinity than do the other centers. This probably occurs for two reasons. First, the location of the regional shopping center in the midst of office and housing development increases the chance that more trips will be made by walking. Second, pedestrian amenities such as sidewalks and crosswalks, which are already common in a CBD, seem to be correlated with density of development.

- *High Occupancy Vehicles* - Vehicles with multiple occupants tend to be highest where transit shares are the lowest, and vice versa. This implies that high occupancy vehicles and transit draw from similar markets and some passengers of high occupancy vehicles may use transit if available.

Freeway accessibility and parking costs were also examined. While UH had the highest average parking cost reported (only $0.26 per trip), the price variation compared to the other centers is not sufficient to explain the variation in mode shares. Likewise, variation in proximity to a freeway does not account for mode share variation. SM and SH have relatively good freeway access and still show high

5.0 TRAVEL REDUCTION MEASURE ANALYSIS

Travel reduction measures at existing regional shopping centers can potentially reduce the number of vehicle trips to the centers and their associated emissions. In this chapter, the travel reduction measures applicable to regional shopping centers are identified, the analytical methodology used to evaluate the travel reduction measures is described, and an application of the methodology to the five case study sites is summarized.

5.1 TRAVEL REDUCTION MEASURES EVALUATED

During the development of the shopper survey questionnaire, a number of measures were identified that may encourage the use of alternative transportation modes were identified. Each of these is described below.

- *More Frequent Transit Service*: Increase transit service on existing routes serving the shopping center.
- *Free Transit Ticket with Purchase:* Provide a free transit ticket with a purchase at the shopping center. Purchases may include spending at restaurants and movie theaters in addition to shopping.
- *Location of Bus Stop Closer to Building Entrance*: Move the location of the bus stop closer to the shopping center entrance to reduce the walk time from the center to the bus and vice versa.
- *Shuttle to Rail Station*: Provide a shuttle from the shopping center to a nearby rail or light rail station to facilitate the use of the rail system.
- *Shopper's Shuttle to Nearby Residences and Businesses*: Operate a shuttle in the residential and business areas nearby the shopping center to eliminate some of the shorter auto trips.
- *Reserved Parking for 3+ Carpools*: Provide reserved parking spaces close to building entrances for people who arrive at the shopping center in a vehicle with three or more people.
- *Bicycle Lanes and Lockers*: Provide both safe and convenient bicycle lanes located on the shopping center grounds and secure bicycle storage lockers.
- *Safe and Convenient Pedestrian Walkways:* Provide of safe and convenient walkways from the surrounding sidewalks and streets to the building entrances.

transit and walk shares. Instead, the critical factors in determining mode share appear to be the location of the center relative to other development and the provision of alternative transportation service.

4.4 CONCLUSIONS

In conclusion, demographic trip characteristics, parking prices and freeway accessibility do not fully explain the differences in mode share among the case study sites. The only variables that appear to be directly related to mode share are the provision of extensive transit services and the characteristics of the surrounding area.

Extensive transit service appears to have two characteristics: it provides many more routes and much more service frequency than the less extensive transit service. Extensive transit service coverage is regional, meaning that routes and stops are spread over a very wide geographic area. In contrast, the less extensive services are characterized by fewer routes, less frequent service, characterized by longer headways (longer time between vehicles), and less coverage across the surrounding region.

Characteristics of the surrounding land use appear to be related to mode share. As the amount of office and residential use per unit of land area in the vicinity of the center increases, the potential of walk trips increases as well. In addition, walking can be facilitated by pedestrian access amenities such as sidewalks and crosswalks, minimal distances to entrances and minimal impedances.

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The analytical methodology for each travel reduction measure is described in detail in Appendix D. The methodologies are designed to enable an analyst to predict trip reduction at regional shopping centers in a sequence of the following four general steps:

1. Determine whether the measure is applicable to a given regional shopping center.
2. Specify input data describing the measure being evaluated.
3. Identify more up-to-date or site-specific assumptions.
4. Calculate percent trip reduction.

In performing the first step, an analyst reviews the criteria for determining whether or not the measure is applicable to a regional shopping center. If the criteria are met, then the analyst proceeds with the subsequent steps. If the criteria are not met, then the measure is not applicable to the regional shopping center and is not analyzed. As an example, one requirement for a shopper's shuttle is that there is not an existing transit system in place serving potential shuttle trips. If there is a transit system in place, experience indicates that the shopper's shuttle would simply replace many existing transit trips. For most of the case study sites, all of the measures were applicable. The only exceptions are listed below.

- SL1: Reserved parking for carpools (existing carpool mode share)
- SL2: Reserved parking for carpools (existing carpool mode share)
- SM: Location of bus stop closer to building entrance (already located)
  Reserved parking for carpools (existing carpool mode share)
- SH: Free transit ticket with purchase (already offered)
  Location of bus stop closer to building entrance (already located)
  Shuttle to rail station (no nearby rail service)
  Reserved parking for carpools (existing carpool mode share)
- UH: Location of bus stop closer to building entrance (already located)
  Shuttle to rail station (no nearby rail service)
  Reserved parking for carpools (existing carpool mode share)

The strategy of providing reserved parking for carpools was not applicable to any of the case study sites because of their high existing carpool mode share. To encourage additional 3+ carpools, the percent of parking spaces that would have to be reserved would need to be greater than the existing percent of 3+

- *Reduced Walking Distance from Sidewalk to Buildings:* Locate shopping center buildings closer to the sidewalk and roadways to reduce the walking distances.

- *Free Home Delivery of Purchased Items:* Provide free home delivery of packages for people who travel to the shopping center by a non-auto mode.

- *Ordering by Phone:* Provide telephone order and delivery services as an option to traveling to the shopping center.

- *Ordering by Computer:* Provide computer and modem order and delivery services as an option to traveling to the shopping center.

5.2 ANALYTICAL METHODOLOGY

To evaluate the trip reduction potential of the travel reduction measures, a methodology that provides a structure for the analysis was developed. The methodology incorporates a series of calculations unique to each measure to more accurately reflect the different factors influencing measure effectiveness. A single equation applying to all measures was not developed because the resulting analysis would have been oversimplified and significant factors would have been ignored.

The methodology included all of the travel reduction measures studied except two: reduced walking distance from sidewalk to buildings and free home delivery of purchased items. A methodology for evaluating reduced walking distance was not applicable primarily because locating buildings closer to the sidewalk applies mostly to the design of new shopping centers. The focus of this study was on existing regional shopping centers. In addition, there was no information available from the literature on the effects of altering walk distances for shopping trips. Free home delivery of purchases could apply to existing shopping centers. This measure was not quantitatively analyzed, however, because it is a strategy that may not encourage the use of an alternative transportation mode when implemented by itself. Instead, free home delivery is likely to support the effectiveness of other travel reduction measures by removing the concern of carrying packages on transit, on a bicycle, or while walking.

The specific calculations developed were based on the empirical data gathered both from the literature review and the shopper surveys. These data were used to shape the structure of the analysis and to provide values used in the analysis. While the values identified are based on the best available information, in some cases the information is sparse. The methodology identifies each variable used in the analysis so that the values can be updated as additional research is performed.

Table 5-1
ASSUMPTIONS FOR METHODOLOGY

Variables	SL1	SL2	SM	SH	UH	Source
More Frequent Transit Service						
Elasticity of transit use with respect to service	-0.76	-0.76	-0.76	-0.76	-0.76	Table D-1
Percent of transit use that equals the trip reduction	50.9%	70.9%	57.2%	50.2%	38.1%	Shopper Survey (1)
Free Transit Ticket with Purchase						
Elasticity of transit use with respect to cost	-0.32	-0.32	-0.32	--	-0.32	Table D-1
Percent of transit use that equals the trip reduction	50.9%	70.9%	57.2%	--	38.1%	Shopper Survey (1)
Location of Bus Stop						
Elasticity of transit use with respect to walktime	-0.14	-0.14	--	--	--	Table D-1
Percent of transit use that equals the trip reduction	50.9%	70.9%	--	--	--	Shopper Survey (1)
Shopper's Shuttle Service						
Percent likely to use shuttle	9.7%	9.7%	9.7%	9.7%	9.7%	Shopper Survey (2)
Percent of shuttle use that equals the trip reduction	48.7%	66.3%	51.2%	39.6%	25.7%	Shopper Survey (1)
Shuttle to Rail Station						
Percent likely to use shuttle	9.9%	9.9%	9.9%	--	--	Shopper Survey (2)
Percent of shuttle use that equals the trip reduction	50.9%	70.9%	57.2%	--	--	Shopper Survey (1)
Bicycle Lanes and Storage Areas						
Percent of trips that would bicycle	3.0%	3.0%	3.0%	3.0%	3.0%	Shopper Survey (2)
Percent of bicycle use that equals the trip reduction	48.7%	67.0%	51.7%	39.6%	25.8%	Shopper Survey (1)
Pedestrian Access						
Percent of trips that would walk	7.7%	7.7%	7.7%	7.7%	7.7%	Shopper Survey (2)
Order by Phone/Computer						
Percent of trips that would order by phone/computer	2.6%	2.6%	2.6%	2.6%	2.6%	Shopper Survey (2)
Percent of phone/computer ordering that equals the trip reduction	48.7%	66.3%	51.2%	39.6%	25.7%	Shopper Survey (1)
Parking Pricing						
Percent of trips that will park outside	11.9%	11.2%	22.2%	16.8%	18.9%	Shopper Survey
Percent of trips that will shop elsewhere	48.4%	50.7%	20.3%	30.5%	17.1%	Shopper Survey
Elasticity of parking demand with respect to out-of-pocket costs	-0.34	-0.34	-0.34	-0.34	-0.34	Table D-1

(#4070/TBLS51-3.WK3)

Notes:
(1) Assumes that use draws from other modes in proportion to their base modal shares
(2) Multiplier of one-third applied to convert from stated preference to predicted use

carpoolers. The lowest share of 3+ carpools was roughly eight percent at UH, and the highest share was more than one-third at SL1. Reserving these percents of the parking spaces near the shopping center entrances would be difficult to implement and enforce. Some reserved spaces would be reasonably far away from the entrance and therefore would not create an incentive to carpool. Instead, the shopper survey results indicate that carpooling is a primary mode for traveling to a regional shopping center, without additional incentives. To further reduce trips, all vehicle travel, not just drive alone, would have to be reduced. Even though reserved carpool parking was not evaluated for the case study sites, a methodology was developed and is included in Appendix F.

The input data define the specific travel reduction measure being analyzed and describe the travel characteristics for the shopping center. For example, to evaluate more frequent transit service, the analyst must specify the percent increase in transit vehicle miles serving the shopping center (defining the measure) and the current percent of trips made by transit (travel characteristic).

The estimation of the percent trip reduction is based on assumptions included in the analysis regarding the reaction of travelers to the measure as described in the input data. These assumptions may be (1) elasticities related to changes in the level of transportation service as suggested by the literature or (2) a sensitivity value based on the stated preference of respondents in the shopper survey conducted for this study. The values for each assumption identified through the literature review and the shopper survey are summarized in Table 5-1. In estimating the sensitivity value based on the stated preferences of the shopper survey respondents, a factor of one-third was applied to translate the stated willingness to use a measure to an expected outcome. The need for this discounting factor and the value of the factor have been identified in the literature, as described in Table D-1.

The final step in the application of the methodology is to use the equations developed to estimate the percent trip reduction. If data are available on the total number of trips made, then these percentages can be used to estimate the daily trip reduction. It should be noted that the methodology is designed to evaluate each measure independently. Because of possible interactions between measures, it is not appropriate to simply sum the estimated reductions across measures.

Table 5-2
INPUT DATA FOR CASE STUDY SITES

Variables	SL1	SL2	SM	SH	UH
More Frequent Transit Service					
Percent of all trips that are transit	4.3%	6.4%	10.6%	21.0%	32.5%
Percent increase in transit vehicle miles	10.0%	10.0%	10.0%	10.0%	10.0%
Free Transit Ticket with Purchase					
Percent of trips that are shopping, eating out, or entertainment	80.2%	78.8%	82.7%	--	69.7%
Percent of affected trips that are transit	2.5%	6.5%	10.9%	--	31.6%
Location of Bus Stop					
Percent of all trips that are transit	4.3%	6.4%	--	--	--
Distance to existing bus stop (feet)	150	200	--	--	--
Distance to proposed bus stop (feet)	20	20	--	--	--
Shopper's Shuttle Service					
Percent of trips within 2 miles	9.0%	11.9%	24.6%	31.3%	38.7%
Shuttle to Rail Station					
Percent of trips traveling over 2 miles	91.0%	88.1%	75.4%	--	--
Bicycle Lanes and Storage Areas					
Percent of trips less than 2 miles	9.0%	11.9%	24.6%	31.3%	38.7%
Pedestrian Access					
Percent of trips less than 2 miles	9.0%	11.9%	24.6%	31.3%	38.7%
Order by Phone/Computer					
Percent of trips that are shopping only	43.5%	42.7%	38.8%	35.2%	15.2%
Parking Pricing					
Increase in hourly parking cost	$0.25	$0.25	$0.25	$0.25	$0.25
Average length of time parked	2.00	1.75	1.50	1.50	2.00
Average roundtrip out-of-pocket costs	$0.95	$0.65	$0.70	$0.65	$1.10

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5.3 APPLICATION OF METHODOLOGY TO CASE STUDY SITES

The analytical methodology developed was applied to each of the case study sites to determine the relative effectiveness of each of the travel reduction measures. A summary of the appropriate input data for the analysis is provided in Table 5-2. Data selected for the travel reduction measures were based on reasoned judgments regarding the type of measure and how it might be applied. The measure applications are for illustration only and are not intended to represent the optimal implementation of the measure. The input data describing the travel characteristics for each site were obtained from the shopper survey.

The analysis for center SM can be used to illustrate the application of the methodology. The first step in evaluating Free Transit Ticket with Purchase as a travel reduction strategy is to determine whether the measure is applicable based upon whether transit service is available. Transit service is available at SM, therefore, the analysis can proceed to the second step, which is to identify input data. For this measure, the variables to be specified are (see Table 5-2):

- percent of trips with a purchase (82.75%); and
- percent of affected trips that use transit (10.9%).

The third step of the analysis is to specify assumptions. A site-specific value for the elasticity of transit use with respect to cost variable was not available, so an average value identified from the literature review was used. Site-specific mode split data were used to specify the second assumption, percent of transit use that equals the trip reduction. This value reflects the percent of new transit users that previously carpooled, bicycled, or walked. The final step is to apply each value identified according to the equations detailed in Appendix F. For this measure, the calculation is as follows:

Percent Trip Reduction = -(-0.32) * (0.827) * (.109) * (.572) = 1.7%

The results of the analysis are provided in Table 5-3. As is indicated, the percent reduction in vehicle trips for most of the travel reduction measures and case studies is fairly low. One notable exception is the provision of a shuttle to a nearby rail or light rail station. The estimated percent reduction in vehicle trips for this measure ranges from roughly two to six percent. This indicates both that rail is an attractive mode of transportation for the shopping center trip if access is easy, and that regional rail

service is available to many of the shoppers (assuming that an individual would not have indicated an interest in this strategy if he/she did not have access to the rail system). As might be expected, the estimated impact from improved pedestrian access is greater for those case study sites that have a higher density of development in the immediately adjacent areas.

The implementation of parking pricing is estimated to reduce the vehicle trips to a regional shopping center anywhere from one-third to one-half. While this may seem very effective, most of this reduction is derived from those trips that are shifted elsewhere. Not only will this negatively impact the regional shopping center economically, it also probably does not reflect any air quality improvement because at the very least, the trip is still being made, and there is no region-wide impact on air quality. The possibility also exists that a longer trip could be made, or that multiple trips are made because the shopper visits individual stores instead of one shopping center.

5.4 USING TRIP REDUCTION ESTIMATES TO CALCULATE EMISSIONS REDUCTIONS

For this research project, methodologies were developed to estimate the potential travel reductions from travel reduction measures implemented at regional shopping centers. As indicated in Chapter 2 of this report, one of the objectives of this research project was to provide assistance to local air districts in meeting the trip and VMT reduction requirements of the California Clean Air Act. A next logical step is to use the estimated trip reductions to calculate reductions in pollutant emissions. While this was not included in the scope of this project, this section provides some guidance on how these reductions might be estimated.

Calculating emission reductions from transportation projects incorporates a number of factors that are unique to an area, but are not related to travel. These factors include temperature, climatic conditions, and topography. Because of the significant influence of these factors, it is generally not appropriate to develop one set of emission factors for use statewide. Instead, air quality software programs should be used with emission rates that are specified for the analysis area. Examples of such software include DTIM and URBEMIS, which both use area-specific emission factors derived from the emission rate model EMFAC. For any travel reduction measure, characteristics that will significantly influence the potential

Table 5-3
ANALYSIS RESULTS

Travel Reduction Measure	Percent Reduction in Vehicle Trips				
	SL1	SL2	SM	SH	UH
More Frequent Transit Service	0.17%	0.34%	0.46%	0.80%	0.94%
Free Transit Ticket with Purchase	0.33%	1.16%	1.65%	–	2.68%
Location of Bus Stop	0.27%	0.57%	–	–	–
Shopper's Shuttle Service	0.43%	0.77%	1.22%	1.20%	0.96%
Shuttle to Rail Station	4.57%	6.16%	4.26%	–	–
Bicycle Lanes and Storage Areas	0.13%	0.24%	0.38%	0.37%	0.30%
Pedestrian Access	0.70%	0.92%	1.90%	2.42%	2.99%
Order by Phone/Computer	0.54%	0.73%	0.51%	0.36%	0.10%
Parking Pricing	55.50%	59.42%	30.77%	40.84%	26.99%
Without percent that will shop elsewhere	7.10%	8.72%	10.47%	10.34%	9.89%

(#4070/TBLS51-3.WK3)

6.0 RECOMMENDATIONS FOR FUTURE RESEARCH

This is one of the first research efforts to assess travel mode choice and the potential effects of travel reduction measures at an indirect source. The findings are intended to assist air quality planners evaluate travel reduction measures at regional shopping centers. Through the course of the study, the project team identified a number of areas that would benefit from further research and study. These areas are described in the following sections.

Implement Demonstration Projects for Travel Reduction Measures

The analytical methodology developed in this study was based on available empirical evidence from the literature and the shopper surveys. Unfortunately, there was little information on the application of the variety of travel reduction measures to regional shopping centers. In the few cases where travel reduction measures have been implemented at shopping centers, evaluations of their impacts have not been performed. Evaluations have been performed for measures that impact commute trips, but there are obvious limitations in applying these results to shopping center trips.

Consequently, demonstration projects should be funded at regional shopping centers to determine the effectiveness of travel reduction measures. This is the best way to include all of the factors that are unique to regional shopping centers. And, by performing demonstration projects at shopping centers with differing surrounding land uses and transportation service characteristics, the impacts of these factors can be further examined. A key part of any demonstration project is the design of an effective evaluation plan prior to implementation. The evaluation plan should include an identification of factors that may possibly impact the effectiveness of the travel reduction measure. Data on these factors should be collected before and after the demonstration project is implemented, as well as at control sites without the measures to rule out the influence of external factors.

What Determines Mode and Frequency of Travel

Most existing regional shopping centers and other indirect sources do not have travel reduction measures in place. The findings of this study suggest that the location of the center with respect to access to alternative transportation modes and surrounding land uses are major determinants of mode of travel. More research needs to be performed to verify these findings. It seems very probable that the reason for high walk shares (and a higher proportion of work-shopping center-work trips) at certain centers has to

emission reduction include a reduction in number of trips, a reduction in VMT, and a change in roadway speeds. Because of the complexity of evaluating emission reductions, it is recommended that local jurisdictions or shopping center management coordinate their efforts with the local air quality districts.

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other shopping areas because of the availability of recreational activities. Research needs to be performed on the relationship between recreational shoppers, mode choice and the implications of travel reduction measures.

Because recreational trips are discretionary trips, it could be hypothesized that disincentives to driving may only serve to shift the trip to another location, or eliminate the trip entirely. Trip elimination could bring negative economic impacts to the shopping center. It could also be hypothesized that recreational trips are more sensitive to travel cost than travel time, which would mean that travel reduction measures that reduce travel cost may be more effective. Another hypothesis is that alternative transportation modes may be more attractive to people who do not have to carry packages. Clearly, research on the impact that the recreational portion of shopping center trips has on travel behavior is needed to address these issues.

Further Specify Elasticities and Sensitivity Factors

The transportation literature is quite sparse and/or dated on shopping trip elasticities for transit fares, transfers and service improvements. More studies are needed concerning the results of changes in these transit variables for shopping trips. Also, because it seems that a considerable proportion of transit trips to shopping centers may be transfers, the elasticity research should focus on prior mode and trip purpose associated with the increased trip making. Finally, not all trips made to regional shopping centers are for shopping. As indicated in the shopper survey, there are many other purposes for making the trip. More studies are needed on the variety of trip purposes to/from the shopping centers, and a comparison between the sensitivities of shopping and non-shopping trips to changes in time, cost and service should be made.

Cycling and walking to regional shopping centers needs much more research. More data on the access to shopping centers via cycling and walking is needed. The data should be collected by time, day, and origin to better understand which trips are most and least likely to be made by walking and cycling. There is also the need to evaluate the effects of improved cycling and pedestrian access to/from shopping centers. While there are some case studies indicating that cycling access improvements have influenced commute trip making, these studies are not comparable studies for shopping trips. Studies should focus on the effects of pedestrian and cycling access routes, as well as on safety and lighting enhancements.

do with both proximity and ease of access to office and residences. Likewise, the highest transit use is at centers in proximity to an extensive regional bus and rail system. Other centers with proportionately less extensive service show lesser transit shares.

Future research on shopping centers and other indirect sources should continue to test the relationship of location and access to mode choice. If a strong positive relationship is found, the research should determine the contributing variables at work and their relative strengths. For example, it may be possible to determine the influence of walk distances or of varying office and residential types and densities. Presuming enough variation in the level and type of transit service, research may also identify the influence of enhanced frequencies and access within the center. The research should also develop and test an index for measuring bicycle and pedestrian access in terms of design features, and use the index to test the relationship of design to pedestrian and cycling use. Finally, this research could be used to determine whether these land use and transportation service features vary in their impact on mode choice between different categories of indirect sources.

Application of Results to Other Types of Shopping Centers and Areas

The results of this project are oriented to regional and super-regional shopping centers, which differ from other types of shopping centers (e.g., community, neighborhood) both in size and in the variety of services offered. Very probably, these other shopping centers exhibit differences in trips purposes, patterns, modes and frequencies. The market for a regional shopping center is also very different in terms of the kinds of shoppers attracted to the center. This study focused on metropolitan urban areas, and characteristics of travel to shopping centers in non-metropolitan areas are also likely to be different. For these reasons, it is not appropriate to apply the results from this study directly to shopping trips to/from other centers. However, there may be lessons learned in this study that would apply to any shopping center. These include the impact of location, surrounding land uses, and transportation services on the use of alternative transportation modes. A critical analysis needs to be performed to determine which results are unique to regional shopping centers, and which have a broader applicability.

Impact of "Recreational" Trip Purpose on Travel to Shopping Centers

As indicated in the variety of trip purposes identified in the shopper survey, travel to a regional shopping center for recreational reasons include eating out, entertainment, socializing, and even exercise. Individuals whose primary trip purpose is shopping may travel to regional shopping centers rather than

- what factors should be used by mode or type of respondent to predict use from stated preference.

The type of evaluations that are needed are those in which data from stated preference surveys gathered prior to the implementation of a measure at a shopping center are compared to data reflecting actual use of alternative travel modes after the implementation of the measure. It may be possible to conduct these evaluations in conjunction with the implementation of demonstration projects.

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Examine Trip Patterns to Shopping Centers

Vehicle trip patterns to/from shopping centers need to be better understood. Some studies suggest a considerable volume of shopping trips may be "linked trips" or "pass-by" trips. The shopper survey conducted as part of this study confirms this finding. More research is needed to determine how these trip-making patterns vary across centers, and to assess whether there exists a relationship between travel patterns and likely mode use.

Analysis of Who is Traveling Together in Vehicles

At each of the case study sites included in this project, a significant proportion of the survey respondents traveled to the shopping center with more than one person in a vehicle. To better understand the apparent prevalence of high occupancy vehicles to regional shopping centers and to determine whether this share could be increased, research is needed to identify the people traveling together to shopping centers. If the majority of high occupancy vehicles are formed by family members and work associates, then there may be limited possibilities to increase the occupancy of single-occupant vehicles. Instead, it may be appropriate to encourage family members and work associates to consolidate trips so that they make fewer trips to a shopping center. Traveling together to a shopping center is not similar to carpooling for a work-related trip, where there are likely to be multiple origins and/or destinations. Typically, carpooling involves consolidating multiple trips that would otherwise be taken individually.

Evaluate the Relationship Between Stated Preferences and Actual Behavior

Until more experience accumulates on the effects of travel reduction measures at regional shopping centers, projections of measure effectiveness must rely in part on revealed preference surveys. These surveys would be more useful if better information were available on the relationship between revealed preferences and actual trip making behavior. As this study suggests, some studies have been done on estimating behavior from stated preferences, but none of these studies are particular to shopping trips or to the modes other transit. Particular issues include:

- whether intention to use or not to use a specific mode is a better predictor of actual mode of travel;
- whether age, gender or current mode bear any relation to predicted behavior;
- whether certain types of questions are more or less likely to elicit better predictions of behavior; and

APPENDIX A

Advisory Committee Members

APPENDIX B

Summary of Shopping Center Literature and Bibliography

ANALYSIS OF INDIRECT SOURCE TRIP ACTIVITY
Advisory Committee Members

Freya Arick/Jeff Kahn Sacramento Metropolitan AQMD 8411 Jackson Road Sacramento, CA 95826 916/386-6660	Nancy Kays Sacramento Area Council of Governments 3000 S Street, Suite 300 Sacramento, CA 95816 916/457-2264
Cheryl Berkey Senior Manager, Consumer Research The Hahn Company 4350 La Jolla Village Drive, Suite 700 San Diego, CA 92112 619/546-3378	Sherry Rogelberg Metropolitan Transportation Commission 101 Eighth Street Oakland, CA 94607 510/464-7700
John Duve Administrator Transportation Demand Management SANDAG 401 B Street, Suite 800 San Diego, CA 92101 619/595-5368	Vagadu Varda California Dept. of Transportation Office of Traffic Improvement Mail Stop 80 P.O. Box 942874 Sacramento, CA 94274-0001 916/445-7352
Morris Dye San Diego County APCD 9150 Chesapeake Drive San Diego, CA 92123-1096 619/694-3307	Douglas Wiele Whitney Development Company 2 Theatre Square, Suite 310 Orinda, CA 94563 510/253-9000
Henry Hilken San Francisco Bay Area AQMD 939 Ellis Street San Francisco, CA 94109 415/749-4642	

(4070/APPDX-A.FNL)

ARB Representatives:

Fereidun Feizollahi
Terry Parker
Anne Geraghty
Roberta Hughan
Malcolm Dole

JHK Consultant Team:

Deborah Dagang, JHK
William Loudon, JHK
Nancy Pitta, Phase III
Clara Marie de Gamarra, Phase III
Tom Higgins, K.T. Analytics

Table B-1
SUMMARY OF SHOPPING CENTER LITERATURE
(continued)

SOURCE	LOCATION	TYPE OF CENTER	DESCRIPTION	KEY FINDINGS
Chambers and Zissler, 11/91	Sacramento, CA	Super-regional and regional shopping centers	Super-regional center 4 miles from CBD. Regional center located 13 miles from CBD.	People living within 5 mile radius of center more likely to visit center than those >10 miles away. Decision to carpool not dependent on distance from home to center. Average carpool vehicle occupancy is 2.0 or greater. "Single strategy" most likely to eliminate auto trip: • free home delivery (15%) • direct transit service (13%) • shuttle home-center with $4 RT fare (13%) • reserved parking for vehicles with occupancy ≥ 2 (11%) • free bus token (92%), dedicated bike lane and storage (9%) • more frequent transit service (7%)
Smith, 8/86	Prince George's County, MD	7 neighborhood/ community shopping centers, 2 regional shopping centers	Defines a methodology for estimating impact of shopping center trips, considering pass-by trips	Suggests that future centers need to be designed/located to maximize # of pass-by trips, not new trips. In future, need to determine if "comparison" shopping facilities are less likely to get pass-by trips because of the location /design within center. If so, need to know how to locate/service differently to maximize pass-by new trips.
JHK & Associates, 3/89	Nationwide	6 office and regional shopping centers	Development of a database of travel characteristics for large-scale, multi-use suburban activity centers	Study concludes midday non-auto use and office proximity highly related. Primary trip purpose is shopping for midday trips (46-84%) and P.M. peak trips. Relatively high transit share at one center attributable to "extensive radial bus system" The larger the center, the greater the percentage of internal trips (31-47% evening and midday). The more office space at a center, the greater the number of office-origin trips to the center.

Table B-1
SUMMARY OF SHOPPING CENTER LITERATURE

SOURCE	LOCATION	TYPE OF CENTER	DESCRIPTION	KEY FINDINGS
TRAVEL CHARACTERISTICS				
Toth, et.al., 5/90.	Calgary, Alberta, Canada	7 suburban regional shopping centers	Study to understand traffic distribution patterns of regional centers and characteristics of shopping trips	Primary trip - shopper leaves origin, goes to center, returns to origin with no intermediate stops. Undiverted linked trip (pass-by trip) - shopping center is intermediate stop between origin zone and destination zone; does not require diversion from origin route to destination. Diverted linked trip - shopping center is intermediate stop between origin zone and destination zone; trip was diverted from original route to go to center. A proportion of trips made are part of a series of linked trips. Shopping trips have several origins and destinations before and after the center. 55.6% of trips were primary trips, 14.3% undiverted linked, 30.1% diverted linked. Some trip types may be more or less amenable to transit, cycling and walk.
JHK, 6/82	Orange County, CA	2 neighborhood / community, 8 super-regional shopping centers	Study to determine the value of public transit service for shopping centers	Trip length varies considerably by center (from 3.3 - 8.2 miles). Average trip length for 10 centers was 5.3 miles. Average passenger spends $19.85 per weekday at the shopping center. Transit ride shares range from 2.7% to 9.5% with transfers, and from 2.0% to 4.4% without transfers.
Slade and Gorove, 1/81	Washington D.C.	Regional shopping center	Study to determine trip type (drop-in, diverted or new) for center-generated traffic during P.M.peak	25% of trips are drop-in, 40% are diverted from other shops to new center when it opens, and 35% are new shopping trips. Suggests that trip reduction efforts must be targeted at new trips.
Kittleson and Lawton, 2/87	Portland, OR	Neighborhood/regional shopping centers	Data collection to determine proportion of trips by trip type (drop-in, diverted or new) during P.M.peak	65% of trips drop-in, 30% of trips are diverted, 5% of trips are new trips. Distribution of vehicles throughout day suggests that P.M.and evening service frequencies may be more important than other times.
Liskamm, et.al., 1984	Daly City, CA	Super-regional shopping center	Study of the benefits to center of providing increased transit service and on-site transit center	17% of bus users under age 18; 19% of bus users over age 65; suggests some transit dependency in users. Mode share for bus is 6.6%; walk mode share is 1.4%; mode share for BART, taxi, other is less than 1%.

Table B-1
SUMMARY OF SHOPPING CENTER LITERATURE
(continued)

SOURCE	LOCATION	TYPE OF CENTER	DESCRIPTION	KEY FINDINGS
Tebinka, 11/89	Manitoba, Canada	1 regional shopping center, 1 super-regional shopping center	Study of transit use at 2 centers where transit was considered during planning for expansion of the centers. 1 center with mode split evaluation before/after transit center development.	Transit mode split decreased 2-3% after transit center built, reflecting overall decline in transit share city-wide. Transit centers individually, transit lanes and lay-bys may or may not increase transit use depending on overall trends in transit for area.
Greater Bridgeport Transit District, 5/87	Bridgeport, CT	4 suburban malls and shopping strips	Study to determine how to encourage people in outlying areas to use fixed-route transit or some other mode instead of auto for trips to shopping centers	Most transit users are transit dependent - over age 60 or under age 18. Must understand market to understand what services are needed. Transit users' most frequent request is for more frequent, direct service; less interest in benches/shelters. Shared-ride taxi service for low income residents may not be very effective because it gets small shop share (2-3% of all trips); more trips are for work. Suggests expanding transit service to non-transit dependent users to get away from "negative" image of transit dependent users; mall owners don't like image.
JHK, 6/82	Orange County, CA	2 neighborhood/ community shopping centers, 8 super-regional shopping centers	Study to determine value of public transit service for shopping centers	24 - 58% of transit trips to shopping centers are transfer trips; primary effect of transit service may not be at centers. Transit mode share ranges from 2.7 to 9.5% with transfers and from 2.0 to 4.4% without transfers. Suggests a transit use ceiling for centers served by 3 - 11 routes.
Liskamm, et.al., 1984	Daly City, CA	Super-regional shopping center	Study of benefits to center of increasing transit service and providing an on-site transit center	6.6% of shoppers at center in December 1980 and January 1981 arrive by Samtrans bus, 16.5% of employees ride transit. (1.4% of shoppers walk, 1% or less use BART, taxi, or other mode.)

Table B-1
SUMMARY OF SHOPPING CENTER LITERATURE
(continued)

SOURCE	LOCATION	TYPE OF CENTER	DESCRIPTION	KEY FINDINGS
Barton-Aschman Associates, Inc., 4/91		Shopping centers of all sizes	Aggregate shopping center data from the ITE *Trip Generation* report	Highest traffic days in year are all Fridays and Saturdays from Thanksgiving through Christmas Eve., the 8 non-Sunday days preceding Christmas Day, and December 26th.
	Nationwide	Regional shopping centers	45 centers with average GLA= 326,000 ft^2	Percentage of pass-by trips is substantial (20-60%) but not clearly correlated to size of center. P.M. peak trip lengths vary from 2.4 to 3.6 miles, increasing with center size.
	Volusia County and Pinellas County, FL	Shopping centers of all sizes	Trip lengths vary depending on size of center	Trip Length (miles) GLA (ft^2) / Volusia County / Pinellas County <49,000: 2.2 / - <100,000: - / 1.4 100,000-200,000: 2.6 / 1.8 300,000-400,000: 10.4 / - 400,000-500,000: - / 2.4 500,000-1,000,000: - / 3.2 1,000,000+: - / 3.6
TRANSIT				
Schneider et.al., 1982	Nationwide	17 super-regional shopping centers	Survey to identify preferences for types of transit service at shopping centers	Shoppers preferred fixed-route service over demand responsive (dial-a-ride) service. To achieve a 10% transit mode split for properly designed service, travel desires of shoppers and employees must be met. Suggested preferences included transit with short waiting times, short walk distances, similar travel time to auto, and low fares. These services more important than covered shelters at centers. Transit users tend to be of lower average income than non-users ($16,695 vs. $28,149). Auto availability for non-transit users (92.9%) is much higher than that for transit users (33.7%).

Table B-1
SUMMARY OF SHOPPING CENTER LITERATURE
(continued)

SOURCE	LOCATION	TYPE OF CENTER	DESCRIPTION	KEY FINDINGS
Black, Howland & Rogel, 1983	San Diego, CA	Super-regional shopping center	Evaluation of transit use at center located in downtown CBD with considerable access to transit	Safety and security of transit use enhanced by heavy sidewalk activity. Extensive, accessible transit can increase transit use. Retailers in Boston and Philadelphia report 70% of shoppers arrive by transit. Transit use enhanced by targeting market population; more walk and transit trips made by office workers, more auto trips by tourists and suburban shoppers. Plaza Pasadena market population of 70% residents/shoppers, 30% office workers was considered in planning.
Liskamm, et.al., 1984	Daly City, CA	Super-regional shopping center	Siting and construction of transit terminal to serve center	Design criteria for transit center included exclusive bus access point, berth space layout/size, covered, secured waiting area, ancillary facilities (telephone, vending machines).
PARKING / PARK-AND-RIDE				
Smith, 1983	Montgomery County, MD	Unknown type of shopping center	Survey of commuters at 3 park-and-ride shopping center sites to determine effects of shopping center park-and-ride on commuter travel and shopping behavior	Survey results indicate 25-45% of park-and-riders/day shop at center on way to or from work. 2/3 of this shopping activity either diverted or was newly induced shopping. If main effect is diverting trips to/from other centers, effect could be positive or negative depending on VMT. If park-and-ride generates new vehicle trips, has negative impact on air quality. Park-and-ride requires more research before being TDM candidate.
Urban Land Institute, 1981.	Nationwide	506 shopping centers of all sizes	Surveys and parking counts taken to determine required number of parking spaces per square foot of GLA	Geographic location does not significantly affect parking demand; no significant difference was found among peak parking demands at comparable centers across the country; parking demand was not influenced by size of nearest city/metropolitan area. Parking demand similar for centers in suburbs when compared to urban centers. Parking demand lower in CBD served by transit and walkways. Study indicates peak period parking demand not related to amount of available parking. 15-20% of all peak period parking taken by employees - 1.6 employee spaces per 100 ft^2 GLA.

Table B-1
SUMMARY OF SHOPPING CENTER LITERATURE
(continued)

SOURCE	LOCATION	TYPE OF CENTER	DESCRIPTION	KEY FINDINGS
Couture and Dooley, 1991	Danville, IL	Not applicable	Analysis of differences between stated intentions and actual use of new transit system; data collected before and after implementation of transit	No significant difference among age or employment groups with respect to intended or actual transit use (3-5 rule). 37% of people saying they intended to use transit actually used it; 84% of people saying they did not intend to use transit actually did not use it. Perception of convenience and auto availability are dominant factors in deciding to use transit.
Fijal, 1989	Chicago, IL	Neighborhood shopping center	4 sites with between 45,000 and 310,000 ft^2 of retail space studied to determine if a relationship between bus service frequency and vehicle trip generation exists	Frequent bus service may affect travel mode but does not appear to reduce vehicle trip generation rates or need for parking. The percent transit is not clearly related to the number of bus lines.
JHK & Associates, 3/89	Bellevue, WA	Regional center with 4.7 million ft^2 office, 3 million ft^2 retail/commercial, 1000 hotel rooms	Development of a database of travel characteristics for large-scale, multi-use suburban activity centers	High percentage of transit use at Bellevue Center attributed to "extensive radial bus service" to center. Center served by 17 bus routes and has transit center in the center of complex.
URBAN DESIGN / LAND USE				
Snohomish County Transportation Authority, 12/88	Snohomish County, WA	Not applicable	Guide giving insight into new approaches to resolving public transportation - land use compatibility issues	Suggests working with transit district to establish standard transit shelter design. Suggest putting transit facility in "shared plaza" or at main entrance. Suggests considering safety, efficiency (minimize loops), transfer opportunities, sight distances.

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Table B-1
SUMMARY OF SHOPPING CENTER LITERATURE
(continued)

SOURCE	LOCATION	TYPE OF CENTER	DESCRIPTION	KEY FINDINGS
NON-MOTORIZED ACCESS				
JHK & Associates, 3/89	Nationwide	6 office and regional shopping centers	Development of a database of travel characteristics for large-scale, multi-use suburban activity centers	2-5% walk mode share for midday trips represents "typical center" with no direct connections to office and no pedestrian amenities.

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Toth, Zoltan B., Dianne M. Atkins, Dan Bolger and Robin Foster. "Regional Shopping Center Linked Trip Distribution." *ITE Journal* 60(5): 41-46(May 1990).

Transportation Research Board, National Research Council. *Simplified Procedures for Evaluating Low-Cost TSM Projects User's Manual*. National Cooperative Highway Research Program Report 263. Washington, D.C.: Transportation Research Board, National Research Council. October 1983.

Trimble, Gerald M. and Stuart L. Rogel. "Horton Plaza: Codevelopment Rebuilds Downtown Excitement." *Urban Land* (July 1983).

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Urban Land Institute. *Dollars and Cents of Shopping Centers: 1990*. Washington, D.C.: Urban Land Institute, 1990.

Urban Land Institute. *Horton Plaza, San Diego, California*. Project Reference File (16)19. Washington, D.C.: Urban Land Institute, October-December 1986.

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APPENDIX C

Annotated Bibliography for Selected Sources

Black, J. Thomas and Libby Howland, Stuart L. Rogel, Ralph R. Widner and Noreen Beiro. *Downtown Retail Development: Conditions for Success and Project Profiles*." Washington, D.C.: Urban Land Institute, 1983.

This publication examines how to relate existing retail activity to downtown events and facilities in an effort to attract metropolitan residents downtown for shopping, eating and entertainment. Horton Plaza in San Diego is cited as an example because its design facilitates a relationship to the street and to the architectural character of the surrounding buildings. The shopping centers discussed in this article are primarily downtown retail sites located in the CBD.

The article suggests that extensive transit can boost transit use. Retailers in Boston and Philadelphia report that 70% of shoppers arriver by transit. The article also suggests the importance of targeting the market population. If a center primarily serves office workers, more walk and transit trips can be expected. If a center primarily serves tourists and suburban shoppers, more auto trips can be expected.

Bourne, Robert T. and Peter M. Schauer. "Case Study in Land Use and Parking Regulations in Support of Campus Transit Services: The Development of Cy-Ride, Ames, Iowa." Paper No. 890523 presented at the 69th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1990.

This paper examines how land use and parking regulations were used in Ames, Iowa to support expanded and improved bus service on the Iowa State University campus. The paper focuses on the "creation of innovative parking policies as the operational key to a strong transit service. Aggressive land use and innovative parking policies are only partial factors in building a strong transit service. Actual management and approach in operations are final links in a successful campus transit service."

"The continued successful provision of fixed route and demand responsive transit service on the Iowa State University campus and throughout the City of Ames has been the result of cooperation between the City of Ames, the University administration and the University students. These three groups have recopgnized the relationship between land use, parking, and transit. In 1981 when CY-RIDE was in its formative stage, they set a course of action agreed to by consensus of reducing available parking and increasing available transit services."

Bul, Alexander and Nicholas Ordway. "Shopping Center Innovations: The Past 50 Years." *Urban Land* 46(6): 22-15(June 1987).

This paper discusses the evolution of shopping centers and highlights the advancements that made the most significant contributions to the design of today's shopping centers. These innovations include: unified blocks of stores, shopping districts, enclosed shopping centers, mixed-use development centers, multi-level downtown centers, festival markets, specialty or theme centers, super-regional centers with up to eight anchor stores, and off-price malls. The trend of using a full-line department store to anchor a regional mall is discussed. An extra-large center is defined as having either one million square feet gross leaseable area (GLA) or multiple (5 to 8) anchor stores.

ANNOTATED BIBLIOGRAPHY FOR SELECTED SOURCES

ATE Management and Service Company, Inc. *Transportation Management Program for Newport Center/Fashion Island.* Report submitted to The Irvine Company. Cincinnati, Ohio: ATE Management and Service Company, Inc., March 1981.

This report outlines and describes the elements of the transportation management program (TMP) developed for Newport Center, a business/commercial complex in Newport, CA. The TMP was developed to encourage ridesharing, transit and other alternative modes of transportation to Newport Center, which was expected to expand twenty-one percent between 1981 and 1987 or 1988. The TMP includes measures such as a carpool matching program and subsidized bus service. The article is very site specific and does not discuss the elements of the TMP in a generalized manner.

Barnett, Theresa. "San Jose Retail Upswing: New Centers and Facelifts." *Northern California Real Estate Journal* 1(21): 11(August 31-September 13, 1987).

The article discusses the rapid residential development growth in San Jose, California and describes the subsequent construction of shopping centers in San Jose and the renovation of existing San Jose shopping centers to include new stores.

Barton-Aschman Associates, Inc. and R.H. Pratt & Co. Division. *Traveler Response to Transportation System Changes.* Second Edition prepared under DOT-FH-11-9579 and submitted to Dept. of Transportation, Federal Highway Administration, Office of Highway Planning, Urban Planning Division, July 1981

The Barton-Aschman study identifies whether shopping center trip data reported in the *ITE Trip Generation* report are appropriate for impact fee computation. Data reviewed include ITE trip generation rates for shopping centers (of all sizes), adjustments for pass-by trips and diverted-linked trips, and trip lengths to shopping centers. Trip length is significant because impact fees are based on vehicle miles of travel. The preliminary conclusions of the study include the following:

1) "The size and type of the shopping center may affect trip generation rates."
2) "More pass-by trip data is needed to make a substantial difference in impact fee computations."
3) The percentage of pass-by trips is substantial (20-60%) but not clearly correlated to the size of the center.
4) Trip lengths vary depending on the size of the center.
5) "Diverted-linked trip data is inconsistent, inadequate and not known to represent a large impact on local roads. It should be given low priority."
5) The highest traffic days in the year are all Fridays and Saturdays from Thanksgiving through Christmas Eve, the eight non-Sunday days preceding Christmas Day, and December 26th.
6) "Site-based trip lengths should be used for impact fee computations."

The time frame for the gains to surpass the losses was assumed to be roughly one to four months, at which point the downtown would experience increased sales directly resulting from the availability of short-term parking in city garages. It was assumed that an increase in parking fees would shift commuters to alternative modes of transportation, which would also decrease peak hour congestion and improve air quality.

Cambridge Systematics, Inc. *Improved Air Quality in Maricopa and Pima Counties - The Applicability of Transportation Measures*. Report prepared for the U.S. Environmental Protection Agency, Region X, San Francisco, California. Cambridge, Massachusetts: Cambridge Systematics, Inc., November 1986.

This report reviews the impacts on air quality and travel characteristics of twelve transportation control measures (TCMs) that have been applied throughout the U.S. and examines whether they could be applied effectively in Pima and Maricopa Counties in Arizona. The study was undertaken because these counties were said to be in non-compliance with various provisions of the Clean Air Act related to attainment of the carbon monoxide standard. Each TCM and the strategies comprising it are defined, and the factors contributing to the TCM's success and effectiveness in prior studies are identified. Also identified is the level of traveler compliance required for the TCM to be effective. Based on examination of land use, population, employment and travel characteristics in Pima and Maricopa Counties, and comparison of these characteristics to the factors influencing the success of the TCMs, the applicability of the TCMs to the Counties was assessed.

Key findings include:

1) The effectiveness of the TCMs throughout the U.S. varies considerably. It was not always possible to assemble existing information on both areawide and site-specific (hotspot) emission reductions for each TCM.

2) All 12 TCM categories were found to be technologically applicable in both Pima and Maricopa Counties in the 10 years following 1986. However, some of the TCMs were expected to produce results in the short term (1-5 years), while others would not produce benefits until 6 to 10 years had passed. The benefits of each TCM and a realistic timeframe for those benefits to be realized is outlined in the report. Benefits are defined in terms of emissions and VMT reduction. The primary market segments (types and locations of trips) affected by each measure is also defined.

Cervero, Robert Dr. *America's Suburban Centers: A Study of the Land Use-Transportation Link*. Final report number DOT-T-88-14 prepared for the Office of Policy and Budget, Urban Mass Transportation Administration. Berkeley, California: University of California, Berkeley, January 1988.

The hypothesis of this article is that employees have been induced to drive to work as a result of the decline in suburban mobility caused by the land use and physical design characteristics of suburban workplaces. The author discusses two types of suburban employment centers (SECs): large mixed-used developments (MXDs) occupying up to 2000 acres with two-thirds dedicated

Callow Associates, Inc. *Parking Study for Neighborhood and Community Shopping Centers*. Report prepared for The Neighborhood and Community Shopping Centers AD HOC Committee. Reston, Virginia: Callow Associates, Inc., October 1989.

"The purpose of the study is to provide a reasonable, accurate and easily implemented parking standard." This report provides a comprehensive assessment of parking demand at neighborhood and community shopping centers (>400,000 ft^2 GLA) in Fairfax County, Virginia. Survey data were collected at over 30 neighborhood centers throughout Fairfax County. Peak parking rates were compared with various attributes of the centers including size, tenant and land use mix, and percent restaurant space. The report recommends that 4.0 parking spaces be provided per 1000 square feet of gross floor area (GFA). (GFA does not include common area within the center, only space leaseable to tenants.) Additional spaces are recommended for centers with greater than 15% restaurant space. The article cites the recommendation by the Urban Land Institute for providing enough parking to accommodate the 20th busiest hour of the year. ULI recommends the following:

Spaces/1000 ft^2 GLA	Size of Center (ft^2 GLA)
4	25,000 - 400,000
4.5	400,000 - 600,000
5	600,000+

Cambridge Systematics, Inc., Applied Development Economics and Research Unlimited. *Downtown Economic Study Final Report*. Report prepared for Sacramento Department of Public Works. Berkeley, California: Cambridge Systematics, Inc., June 1989.

This report discusses the results of a study to determine if an increase in municipal parking rates in downtown Sacramento would impact the Sacramento downtown economy. One of the main concerns about the rate increase was that it would negatively impact the economy by providing a disincentive for commuters to drive into the downtown and commuters significantly contribute to the downtown economy.

The findings of the study indicate that the diversion of people from their vehicles will result in an initial loss of retail dollars to the downtown economy. The modeled results produced by the study predict a fifty-five percent drop in person trips to the downtown due to a parking rate increase of sixty cents. (This reduction represents less than one percent of the total number of people currently parking at city owned lots.) However, losses would only be temporary and would be outweighed by the following projected gains:

1) Parking spaces would be freed up. In time this would lead to the perception that parking in the downtown area is not as difficult as it was previously. This would attract new shoppers to the area, which in turn would put retail dollars back into the economy.

2) Sales of alternative modes of transportation would increase.

shuttle group ride from home to center @ two dollars each way (13%), reserved parking for two or more (11%), free token for the bus (9%), more frequent service (7%).

City of Albuquerque Transit Department, Sun Tran Holiday Shuttle, Albuquerque, N.M: City of Albuquerque Transit Department, January 1993.

This report describes a shuttle service that was implemented during the holiday season to transport passengers between two major shopping malls in Albuquerque, New Mexico. The purpose of the shuttle was to reduce the number of vehicle trips between the centers, which are located in an EPA non-attainment area that historically exceeds EPA air quality standards between November and January. The shuttle was operated for twenty-seven days and ran each day from one hour after the malls opened until half an hour after the malls closed. There was one designated shuttle stop at each mall. The shuttle was advertised on two major television stations and promotional activity, paid for by the Transit & Parking Department, included significant radio advertising and distribution of fliers to shoppers at the malls. Total ridership for the 27 days was 12,894 riders, an average of 478 per day. During the midday period and on weekends the ridership demand exceeded the capacity of the vans, requiring passengers to wait for a van. The estimated cost of the van was $45,919. The shuttle provided several benefits including reduced congestion and vehicle emissions in the area, publicity for the Sun Tran bus system and public-private participation. Improvements to the system include the use of larger vehicles, better signage and identification of stops, provision of service for a longer time period and more promotion.

COMSIS Corporation and Harold Katz & Associates. *Evaluation of Travel Demand Management Measures to Relieve Congestion.* Final report number DOT-T-90-14 prepared for Federal Highway Administration, U.S. Dept. of Transportation. Silver Spring, Maryland: COMSIS Corporation, February 1990.

"The report summarizes the results of a research study, sponsored by the Federal Highway Administraton, to investigate the effectiveness of existing Travel Demand Management programs. This investigation consisted of the evaluation of a number of existing TDM programs located within the United States. The programs, many of which are well known, are varied in size, setting, motivation and accomplishments. The purpose of the study has been to measure directly the quantitative impact of these varied TDM approaches on reducing low-occupancy vehicle trips. The approach was to evaluate each TDM program as a separate case study, using the same set of evaluation tools and guidelines for each."

The findings of the study show that Travel Demand Management can significantly reduce the demand for drive-alone vehicle travel, which in turns alleviates the need to add capacity to the highway system. "Trip reductions such as those discovered could have a major impact on the demand for future infrastructure construction if TDM programs with the proper elements were implemented at a larger scale." The report also identifies the level of reduction in vehicle travel that would constitute a significant expectation for TDM. It sets a goal of 20% to 40% trip reduction for TDM.

Couture and Dooley. "Analyzing Traveler Attitudes to Resolve Intended and Actual Use of a New Transit Service." *Transportation Research Record* 794(1991): 27-33.

to office space, and subcities, newer, larger MXDs on the fringe of large metropolitan areas. Both MXDs and subcities include residential space.

Fifty-seven SEC case sites were sampled using two surveys. It was found that as SECs get denser and the variety of land uses grows, the drive-alone commute decreases. Ridesharing levels are highest when there are substantial commercial components. It appears that the availability of retail activities induces employees to carpool or vanpool. The author suggests that the availability of moderate-priced housing could be inducing some employees to reside near and walk to work.

The study presents the statement that the three site variables that most strongly influence employee travel behavior and local traffic conditions are density, size and land use mixtures. SECs with the highest densities have the highest ridesharing and transit usage and most congested local streets. This suggests that the critical mass of employment is necessary for successful carpools and vanpools in the suburbs. Cervero presents the paradox of density in suburbia: in the short term employees drive to work, local streets become congested, and activities intensify. In the long term density is needed to build up the ridership base to sustain transit and ridesharing activities.

Chambers, Clifford and A.J. Zissler. *Survey Implications for Suburban Mobility Strategies*. Report submitted to Sacramento Area Council of Governments. Menlo Park, California: Crain & Associates, November 20, 1991.

This report discusses the results of a survey to study the travel characteristics of employees and visitors at two Sacramento activity centers: Arden Fair/Point West and Sunrise/White Rock. The study provided the following information:

1. People living within a five mile radius of the center are more likely to visit the center than those living over ten miles away. A regional shopping center draws from a wider geographical area.
2. Where bus and/or rail service to the center was minimal, many people perceived that it was not even possible to get to the center using transit.
3. The distance from home to the center was not considered to be a factor in determining whether to carpool. When people do carpool, average vehicle occupancy is 2.0 or greater.
4. Sunrise attracts more repeat visitors than does Arden Fair. Trips to Sunrise are short in length and parking is plentiful.
5. Improved bicycle access for short trips may reduce auto trips.
6. Visitors would consider using fixed-route service to the center if it was easily accessible of if the center was close to the downtown. Arden Fair had 10% non-auto trips and it is partly because of its proximity to urban Sacramento.
7. Low population density and dispersed travel patterns make fixed-route transit service difficult. According to TRB guidelines, a successful transit system typically requires 4000 persons/square mile for densely spaced routes and 2000 persons/square mile for widely spaced routes.
8. Survey results indicate that the three services most likely to alter commuters' driving alone to the center are free home delivery, direct regional transit service and shuttle service with a fare no greater than two dollars.
9. Survey respondents ranked the "single strategy" that would be most likely to influence them to use a non-auto mode instead of driving to a shopping center in the following order: free home delivery (15%), direct transit from neighborhood to center (13%),

It was also found that bus-accessible neighborhood shopping centers do not attract large numbers of bus users. This suggests that there may be behavioral factors working against the use of public transportation. These factors may include the following:

1) Excess free parking;
2) The size of the goods being sold at the center: large and bulky goods are difficult to carry on public transportation; and
3) The perception of the highly mobile auto-user that public transportation cannot provide the same mobility.

The findings of this study are contradictory. This work also indicates that the percent transit is not obviously related to the number of transit lines provided, which suggests caution regarding the effect of altering bus routes.

Gern, Richard C. "Parking Demand at the Regionals." *ITE Journal* 48(9): 19-24(September 1978).

"The purpose of the study was to investigate peak parking accumulations at regional shopping centers with 800,000+ square feet of gross leaseable area (GLA) and to determine peak parking demand." The study, done from 1973 to 1975, used aerial photography to count parked cars. It was observed that the average parking demand was 5.0 spaces or less. This included observations during the Thanksgiving to Christmas shopping season. The observed parking standard was compared to the 1965 ULI standard parking requirement of 5.5 spaces per 1000 square feet of GLA. (The 1981 version of the same ULI article, "Parking Requirements for Shopping Centers," declares that 5.0 spaces per 1000 square feet of GLA is sufficient. That article is also reviewed in this section.)

It was determined that fuel shortages and fuel price increases have a negligible effect on parking demand. It was also noted that if the standard parking requirement went from 5.5 spaces to 5.0 spaces, a significant conservation of land would result. For instance, 4.0 acres of parking space would not be needed for centers with over 800,000 square feet of GLA. The benefits of this include:

1) Additional space could be allocated for retail space;
2) Lower development and maintenance costs for parking lot areas;
3) Land on perimeter of lot could be used to widen roads leading to the center; and
4) Commuter park-and-ride lots could be developed.

It was recommended that existing centers with excessive parking should be encouraged to develop additional retail space to better use the underutilized land. It was also suggested that standards be developed for specific types of shopping centers. Interesting to note was that "significant differences were noted in the peak parking demand rates for shopping centers of similar sizes, function and compositions in different demographic and geographic areas of the U.S."

Greater Bridgeport Transit District. *Transit Services for Suburban Shopping Malls and Shopping Strips*. Final Report number UMTA-CT-09-0026-87-1 prepared for the U.S. Dept. of Transportation, Urban Mass Transit Association. Bridgeport, Connecticut: Greater Bridgeport Transit District, May 1987.

This paper describes an analysis that explores the differences between behavioral intentions and actual use of a new transit service by using data collected before and after implementation of a new transit system in Danville, Illinois. It was found that reported intentions to use a new transit service significantly overstate actual use once the service has been implemented. Also, negative intentions are better indicators of non-use than positive indicators are of use. Situational factors, attitudes and biases are important determinants of mode choice. It was found that attitudes and behavior are interdependent. Other key findings presented in this article include:

1. For every person that uses transit, approximately three people say they intend to use it.
2. There is no significant difference among age or employment groups with respect to intended or actual use.
3. Thirty-seven percent of those saying they intended to use transit did, while eighty-four percent of those saying they did not intend to use transit did not.
4. Perception of modal convenience is a dominant factor in intentions and actual choice of transit use.
5. Auto availability is a key determinant in mode choice.

Etchart, Graciela, Bethany Whitaker, Cy Ulberg, University of Washington Graduate School of Public Affairs, University of Washington and Washington State Transportation Center. "Local Option Commercial Parking Tax Evaluation, Puget Sound Region, Washington State." Paper number 920753 presented at the 71st Meeting of the Transportation Research Board, Washington, D.C., January 1992.

This paper summarizes an analysis of a proposed local option commercial parking tax. "The goals of the tax are twofold: 1) to raise revenue for transportation purposes and 2) to discourage drive-alone commuting. The study examines the effectiveness of a parking tax as a TDM tool. The results of the analysis revealed that the inequities and administrative costs associated with the tax seemed too high to justify any potential gains from the tax. However, it was recognized that a tax could help reduce parking demand or raise tax revenues."

Fijal, Alan R. "Trip Generation at Neighborhood Shopping Centers with Frequent Bus Service." *Operations Review* 6(1): 1-21(Summer 1989).

The purpose of this study was to determine if there is a relationship between frequent bus service and vehicle trip generation rates at neighborhood shopping centers. The question of whether centers with bus service have lower vehicle trip generation rates than those without bus service was specifically addressed. Four sites in Chicago were studied, all with between 45,000 and 310,000 square feet of retail space and a medium-sized anchor store. Traffic counts were taken at the driveways to the centers.

The study results supported the idea that frequent bus service may effect travel mode. However, the availability of frequent bus service does not appear to reduce the need for automobile parking spaces nor does it significantly reduce vehicle trip generation rates. When sites with and without bus service were compared, those with bus service generally had higher vehicle trip generation rates than those without.

The author studies the impact of large special events, such as concerts and sporting events, to aid city officials in the planning of future large special events. The significance of large special events is that they are viewed as a means of economic development. The study was performed in 9 metropolitan areas nationwide. Findings relevant to the ARB study include the following:

1) Transit usage where regularly-scheduled special transit service is available is much higher than where charter or non-scheduled special transit service is provided. This is due to user familiarity with regular transit service and lower fares for it in comparison to fares for charter or non-scheduled service).
2) Fares have a significant impact on transit mode share.
3) Parking cost does not appear to significantly affect average auto occupancy.
4) Preferential parking for transit plays a role in people using park-and-ride lots and transit. Advertising special event service also plays a role in promoting the use of transit.

Hatcher, S. Gregory and Hani S. Mahmassani. "Daily Variability of Route and Trip Scheduling Decisions for the Evening Commute." Paper presented at the 71st Meeting of the Transportation Research Board, Washington, D.C., January 1992.

The paper describes a study in which the departure times and routes of the commute return trip home was varied. The models studied are referred to as a trip chaining model and a switching analysis model. Trip chaining is the linking together of trips to various destinations. Switching analysis is an study of changing departure times of the commute trip home to avoid bad traffic conditions. The objective of the study was to determine what effect trip chaining had on the variability of route options. The models relate observed route and departure time switching patterns to commuter characteristics such as workplace conditions, socio-economic attributes and traffic system characteristics.

The findings include the following:

1) Thirty-nine percent of all studied commuters contained at least one intermediate stop, emphasizing the importance of trip-linking in commuting behavior.
2) Trip chaining significantly influenced route switching behavior.
3) In general, commuters alter their departure times more frequently than the actual routes that they take. This reflects the availability of more choice in departure time than in available routes.

Heffernan, Kathryn Z. "Traffic Impact Analysis for Creekside Market Place: A Cast Study." Paper presented at the National Conference on Effective Planning Techniques for Small and Medium-Sized Urban Areas, Phoenix, Arizona, December 6-8, 1988.

This paper describes a traffic impact analysis done for a proposed shopping center with 329,300 square feet of retail space, in Glendale, Arizona. The paper include a site analysis, trip generation model, site traffic assignment, and projection of future conditions with and without the development. The discussion is completely site specific and does not talk about shopping center trip generation or trip characteristics in a general sense.

The purpose of the study was to determine how to shift trips to outlying shopping areas within the Greater Bridgeport Transit District from auto trips to either fixed-route transit trips or trips by some other alternative mode. The objective of the study was to design and implement these services and to explore private sector involvement in providing or improving transit services and facilities. Through site analyses and survey results it was found that transit must be convenient to the shopper in order for it to be a viable alternative. The following factors were considered important in determining convenience: access to shopping center, trip length, frequency of service, trip comfort and availability of service information to plan trips.

Transit routes are perceived to be inconvenient if they do not enter the center's parking area; people do not want to walk. However, congested parking lots could cause the buses to be off schedule if they have to drive through the parking lot. A transit route planner may consider congestion a reason to not route transit through the parking lot. The availability of route and schedule information at the shopping center could also encourage shoppers to use transit. Lastly, this study found that the transit district must commit to serving the shopping center before transit service is implemented so that all physical changes and construction of transit facilities required at the center can be made.

Survey results showed that people want shelters and benches, frequent and direct service and better transfer connections. Shopping trips are beneficial to transit because they are not as peak-oriented as commuter trips. Trip length is perceived as being a big drawback to using transit. The study also looked at the possibility of providing demand-responsive service such as group taxi rides as an alternative. However, the advantage of direct service is offset by the disadvantage of having to wait for the return trip.

This article discussed the idea that transit operators must convince merchants that transit-dependent people are worth serving. It is not uncommon that transit-dependent people are perceived as being poor and undesirable to have in the shopping center. It may even be perceived that transit-dependent people may scare away the "good shoppers". The way to discredit these ideas is to emphasize to merchants that these people spend a significant amount of money at the shopping center.

Key findings presented in this study include the following:

1. Most transit users are "transit dependent" - over age 60 or under age 18. They most frequently request more frequent, direct service and have less interest in benches and shelters.
2. Shared ride taxi service for low income residents gets small (2-3%) shop share; most trips are for work. Suggests that demand responsive service may not be very effective.
3. The report suggests that expanding transit service to non-transit dependent people may diminish the "transit dependent image" mall owners don't like.

Green, Charles P. "Mode Split at Large Special Events and Effects on Air Quality." Paper number 910537 presented at the 70th Annual Meeting of Transportation Research Board, Washington, D.C., January 1991.

1) Transit plays an important role in serving the studied shopping centers and contributes significantly to the business generated at the shopping center (as measured by the number of transit riders and the amount of money that they spend).
2) Well-designed transit service can attract a significant number of riders even if the predominant mode of transportation is the auto.
3) Shopping centers are not only destinations but also transfer points and terminals for transit riders.
4) Better cooperation between transit and shopping center industries will benefit each party.
5) Transit plays a significant role in the transit riders' choice of where to shop.
6) Trip length to the center varies significantly, ranging from 3.3 miles to 8.2 miles, with an average of 5.3 miles.
7) Twenty-four to fifty-eight percent of transit trips to the centers are transfer trips. Suggests that even if transit ridership is increased, the primary effect of is on trips other than to the center.
8) Transit share ranges from 2.7% to 9.5% with transfers and from 2.0% to 4.4% without transfers, suggesting there are bounds for transit to centers served by three to eleven bus routes.
9) On average, each passenger spends $19.85 per weekday, suggesting that transit passengers spend "not insignificant" amounts.

ITE Technical Council Committee 6A-29. "Transit Service to Regional Shopping Centers." *ITE Journal* 56(7): 19-22(July 1986).

"The location of regional shopping centers near freeways and the large amounts of on-site parking make it difficult to generate demand for effective public transit service." The amount and type of existing transit service to regional shopping centers is not related to shopping center characteristics such as size and parking requirements.

There are three special interest groups to consider in assessing transit service to regional shopping centers: the transit user, the transit operator and the shopping center owner. Each interest group has a set of objectives which at times conflict with one another. In order for transit to capture a significant share of trips, the following concerns must be addressed:

1) Service area definition: who gets service
2) Convenience of service: number of transfers, minimize travel time, minimize waiting time, hours of transit operation, minimize walking distance, on-site amenities, distance from the road to the shopping center, minimize safety hazards, minimize operating costs, bus storage and turn-around facilities, transfer centers, minimize on-site transit space, minimize on-site congestion, minimize operating subsidy, and minimize security and maintenance costs.

JHK & Associates. *Cottonwood Shopping Center - Traffic Impact Study*. Phoenix, Arizona: JHK & Associates, February 1988.

This report is a traffic impact analysis for a proposed shopping center in Cottonwood, Arizona. It includes a site description, a description of existing conditions, a trip generation and traffic assignment model, capacity analysis, slip ramp options, and summary and recommendations for

Hooper, K.G. and JHK & Associates. *Travel Characteristics at Large-Scale Suburban Activity Centers.* Preliminary Draft Final Report prepared for National Cooperative Highway Research Program, Transportation Research Board, National Research Council. Alexandria, Virginia: JHK & Associates, March 1989.

The objective of this study was to develop a database on travel characteristics for large-scale multi-use suburban activity centers (SACs). Five specialty shopping centers, six community and neighborhood centers and seven regional centers were studied. All of the sites were mixed-use developments comprised of office, retail, residential, hotel and restaurant space. South Coast Plaza was one of the study sites. The main findings include:

1. The majority of the seven surveyed regional malls had lower trip generation rates than those assumed using ITE data.
2. A large portion of trips to and from regional malls are internal to the SAC. The proportion of internal trips gets larger with the size of the SAC.
3. SACs with a large percent of hotel and/or office space have considerable midday walk trips (i.e. 17%). Typical regional malls and SACs have walk mode shares of roughly 4%.
4. There is considerable interaction between buildings within an SAC.
5. Traffic congestion is a main concern of all tenants of the surveyed SACs.
6. Midday non-auto use and office proximity are highly related.
7. High transit usage at Bellevue, WA site is attributed to "extensive radial bus service."
8. Two to five percent walk mode share for midday trips represents "typical center" with no direct connections to office and no pedestrian amenities.
9. The primary trip purpose during the midday and PM periods is shopping (46-84%).
10. There needs to be more support for the importance of links to regional transit and pedestrian links to nearby offices.
11. The larger the center, the more internal trips (31-42% midday and PM).
12. There are more trips with office origins at large centers iwth more office space.

Recommendations to alleviate traffic congestion:

1. Serve the SAC with radial bus service.
2. Connect building sites with pathways and provide pedestrian overpasses and underpasses across highways and parking lots.
3. Provide more mixed-use centers: Serve the needs of employees and tenants with intra-site trips.

The paper also estimates pass-by trips and mode split for shopping centers of varying sizes and compares the observed results to the ITE averages. It was found that pass-by rates for retail centers in large SACs were less than those for comparable-sized isolated retail sites.

Hsu, Dick. "Shopping Center and Transit Service." *ITE Journal* 54(9): 20-24(September 1984).

This paper highlights information from JHK & Associates' Orange County Shopping Center Study in which 10 centers in Orange County, California were studied. The author summarizes the main findings of the JHK report into the following list of significant results:

JHK & Associates. *Trip Generation Study for Prince George's County.* Report prepared for the Maryland-National Capital Park and Planning Commission, Prince George's County. Alexandria, Virginia: JHK & Associates, February 1984.

This reports states that the percent of pass-by trips to a shopping center can be related to the size of the center.

Kenyon, Kay. "Increasing Mode Split Through Parking Management: A Suburban Success Story." *Transportation Research Record* 980(1984): 65-69.

This paper describes the results of limiting parking and raising parking costs at a specific employer site in an effort to reduce the drive-alone commute percentage. The site is a Pacific Bell location in suburban Seattle. 900 employees work at the site, while only 420 parking spaces are provided. (Pac Bell changed locations from Seattle to suburban Bellevue; the measures were introduced when the site changed.) Management set monthly parking fees at $60 as a disincentive to drive-alone commuters. It also provided discounted or free parking for carpools and worked extensively with the regional ridesharing program and the city ridesharing staff.

The program was incredibly successful, achieving a 60% carpool percentage, a 17% transit split, and only a 19% drive-alone split. (It is assumed the remainder use some other mode(s).) The program was successful for a variety of reasons. First, the firm was concerned enough about reducing drive-alone trips to hire an Employee Transportation Coordinator (ETC) one and a half years before the company changed sites. The ETC established a good relationship with local rideshare agencies. Second, disincentives to parking and incentives to carpooling worked well. Third, employees were accustomed to using transit to go to the Seattle location so they were not in the habit of driving to work. Changing transit routes was not as difficult as changing mode.

Kittelson, Wayne K. and T. Keith Lawton. "Evaluation of Shopping Center Trip Types." *ITE Journal* 57(2): 35-29(February 1987).

"The purpose of the article was to describe the results of recent field studies aimed at identifying the net traffic impact of commercial establishments on the surrounding street system." A major regional center near Washington, D.C. and two sites in Portland were studied and lead to several conclusions:

1) Commercial developments containing between 100,000 and 200,000 gross ft^2 of floor area typically generate relatively few new vehicle trips;
2) Commercial centers located on major arterials are likely to draw a significant percentage of their total customers from the passing traffic stream; and
3) The net traffic impacts of commercial activities quickly dissipate as the distance from the commercial activity is increased.
4) Commercial developments of 100,000 to 200,000 square feet gross floor area experience significantly higher percent of drop-ins than typically assumed. The location of the center affects the drop-in rate, the image of the center, the type of good sold and name recognition of the center." (Drop-in trips already exist on the roadways that provide primary access to the new center. They are the same as undiverted linked trips.)
5) Very few of commercial centers driveway trips are new to the surrounding street system.

the center. It is completely site specific and does not describe trip generation rates or trip characteristics to shopping centers in a general sense.

JHK & Associates and Merritt A. Neale & Associates. *Fairfax County Technical Parking Standards Study*. Final report prepared for the Office of Transportation Fairfax County, Virginia. Alexandria, Virginia: JHK & Associates, May 1986.

The purpose of this study was to develop a technical basis for the evaluation and modification of requirements for parking and loading in the Fairfax County Zoning Ordinance. The goal of the study was to identify deficiencies in parking and loading requirements and to develop a technical foundation for establishing requirements which would satisfy the parking needs for new land development. The results of this study verified the ULI recommendations for the sufficient number of parking spaces to be provided per 1000 square feet of GLA at shopping centers.

JHK & Associates, "Fremont Hub Traffic Analysis," prepared for Bank America Realty Services, Inc., October, 1982.

This report discusses the traffic impacts of expanding Fremont Hub, a medium-sized (total area is roughly 578,000 square feet) shopping center in Fremont, California. The report details movements into and out of the center and on local streets. Mitigation measures for newly generated trips are discussed as well. It is completely site specific and does not attempt to make general conclusions applying to all shopping centers.

JHK & Associates. *Shopping Center Transfer and Transit Service Analysis*. Report prepared for the Orange County Transit District. Emeryville, California: JHK & Associates, June 30, 1982.

The goal of this study was to determine the value of public transit service to shopping centers. The purpose of this study was to determine the passenger characteristics and travel patterns at ten shopping centers in Orange County, California. The study looked at the following existing operations: regional transit access, shopping center circulation, passenger facilities, transit patronage, passenger demand vs. pass-through volume, and on-time performance. It also looks at the following deficiencies and mitigation measures: access, productivity and effectiveness, internal circulation, and signing and amenities.

The main findings of the study are:

1) Transit plays an important role in serving the studied shopping centers and contributes significantly to the business generated at the shopping center (as measured by the number of transit riders and the amount of money that they spend).
2) Well-designed transit service can attract a significant number of riders even if the predominant mode of transportation is the auto.
3) Shopping centers are not only destinations but also transfer points and terminals for transit riders.
4) Better cooperation between transit and shopping center industries will benefit each party.
5) Transit plays a significant role in the transit riders' choice of where to shop.

"This study reviews experience with transportation systems management (TSM) and parking management (PM) through through employer case studies and synthesis of suburban demand management literature. It provides recommendations to local government decision makers and planners on strategy effectiveness and implementation, as well as adoption and implementation of demand management or trip reduction policy instrucments. Recommendations are offered about when TSM and PM strategies and policies are appropriate; considerations in selecting policy instruments; suggestions on policy design; and guidance on program monitoring, enforcement, management, costs, and timelines." The study is specific to employers; no discussion of shopping centers is included.

Recommendations for the Federal Government include development of model ordinances, developer agreements, parking codes and guidelines supportive of local policies; changes in tax law on parking subsidies and parking policies for federal employees; support of Transportation Management Association roles in parking management; coordination with air quality regulations; and future research on suburban successes and failures."

Liskamm, William H., Robert Conradt and Gruen Gruen & Associates. *Serramonte Transit Center Study*. Final Report prepared for San Mateo County Transit District. Washington, D.C.: The Administration: Distributed in cooperation with Technology Sharing Program, Office of the Secretary of Transportation, 1984.

This paper studies the benefits to the Serramonte Shopping Center in Daly City, California of increasing transit service and ridership. It discusses the siting and construction of a transit terminal to serve the center and describes a list of major factors to be considered in the planning, location, design and financing of transit centers. The benefits discussed in the paper resulting from increasing transit service include the following:

1. Increased market for retail sales due to more shoppers having convenient access to the center; and
2. Reduced parking requirement from 5 spaces per 100 ft^2 GLA to 4.5 spaces per 1000 ft^2 GLA.

It was determined that a greater share of the transit market would be captured if the service is frequent, easily accessible to people's homes and minimizes trip length. The benefit to the transit agency is increased patronage during off-peak periods which would bring in more farebox revenue. To promote bus ridership it would be necessary to provide route and schedule information to shoppers and to sign pedestrian access areas for the buses.

Serramonte sited a bus terminal to reduce the impact of buses in the parking lot and to improve circulation in the lot. The convenience to the bus patrons was not the main factor in siting the terminal. This is partly due to the fact that the bus ridership was not particularly high.

The paper presents the idea that increased transit ridership leads to reduced parking requirements which in turn leads to a greater area for retail space and, in the end, greater profit. The problem with this concept, however, is that it is not known whether increased transit patronage will actually reduce parking requirements. A substantial survey effort would need to be undertaken to confirm this. In contrast, the value of the parking space is oftentimes used to support arguments of retaining a maximum number of spaces regardless of other considerations. The

6) Twenty-five percent of trips are drop-in, forty percent diverted and thirty-five percent are new shop trips.
7) The distribution of trips throughout the day is heavier in the PM and evening.

Komanoff Energy Associates, Transportation Alternatives and Konheim & Ketcham. "The Environmental Benefits of Bicycling and Walking in the United States." Paper number 930234 presented at the 72nd Annual Meeting of the Transportation Research Board, Washington, D.C., January 1993.

In this paper the fuel and emissions savings resulting from current levels of walking and cycling are estimated. "Based on 'high' estimates of miles traveled by byicycling and walking, these combined modes displace between 1.2% and 2.4% of passenger vehicle emissions of CO, NOx and VOC. Asdditionally, bicycling and walking displace as much as 1.6% of passenger vehicle CO_2 emissions." Key findings include:

1) Developed high/low projections for bicycling and walking in the U.S.
2) Estimates that 26 to 32% of walk miles displace auto mile, and 38 to 56% of bicycling miles displace auto mile. The remainder of walk and bicycle trips would have been by carpool, transit or not at all.
3) By the year 2000, cycling increases by a factor of 3 (low estimate) or by a factor of 5 (high estimate, while walking increases by a factor of 1.5 (low estimate) or by a factor of 2.5 (high estimate).

The following table was presented in the report:

ENVIRONMENTAL BENEFITS OF BICYCLING AND WALKING, 1990-1991

	Bicycling - High Estimate	Bicycling - Low Estimate	Walking - High Estimate	Walking - Low Estimate
Bicycling/Walking Miles Traveled (millions)	21,300	5,800	44,100	26,300
Passenger Vehicle Miles Displaced	12,000	2,200	16,100	5,400
Vehicle Miles Displaced by Bike/Walk Mile	.56	.38	.37	.26

The last row of the table can be interpreted as a "VMT elasticity": every bike/walk mile encouraged by TDM strategies would result in this number of vehicle miles "displaced" or reduced.

K.T. Analytics, Inc. *An Assessment of Travel Demand Management Approaches at Suburban Activity Centers*. Final report prepared for Department of Transportation, Transportation Systems Center. Frederick, Maryland: K.T. Analytics, Inc., July 1989.

This report discusses the results of a survey to study the travel characteristics of employees and visitors at two Sacramento acitivity centers: Arden Fair/Point West and Sunrise/White Rock. Meta was responsible for all survey work and summarizing of results. This report presents only numerical survey results. Interpretation of the results is presented in the Clifford Chambers and Crain & Associates, Inc. paper discussed previously.

New Hampshire Department of Public Works and Highways, Planning and Economics Division. *Traffic & Trip Generation Characteristics of New Hampshire Shopping Center.* Concord, New Hampshire: New Hampshire Department of Public Works and Highways, Planning and Economics Division, January 1977.

The purpose of this study was to gain a better understanding of traffic variation patterns and trip generation characteristics at New Hampshire shopping centers. Twelve centers, ranging in size from 50,000 square feet to 400,000 square feet, were sampled. (According to the ITE, these are not large regional shopping centers, which it defines as one million square feet or more.) Traffic entering and exiting the centers was counted for varying lengths of time. The following are the results:

1. Shopping centers generate more traffic than any other type of development of comparable size.
2. Tuesday and Wednesday were the lowest volume days and Friday and Saturday were the highest volume days on average.
3. The larger shopping centers had different hourly variations in parking accumulation than the smaller centers. Small centers had an even inbound stream until 6 p.m., at which point inbound trips declined sharply. The large centers had considerably fewer inbound trips than the smaller centers during the day, but they experienced a tremendous increase beginning at 4 p.m. and peaking at 6 and 7 p.m. The suggested reason is that the larger centers attract patrons from greater distances.
4. There is no noticeable relationship between average vehicle occupancy (AVO) and the size of the shopping center. Average AVO for all centers was between 1.8 and 2.1.

Parker, Richard. "Traffic Characteristics of Major Retail Developments." From the proceedings of Seminar E, Retail Planning and Development: What Next - Where?, PTRC Annual Meeting, University of Sussex, England, July 15-18, 1985.

This paper about free-standing regional centers in the UK presents a review of published information regarding the traffic impacts of such centers along with specific observed data and survey results. A regional shopping center was considered to be equivalent to a 250,000 square foot mall. A superstore was defined as a single store with 25,000 to 50,000 square feet of retail space, while a hyperstore was defined as a small center anchored by one major occupier along with a number of small service shops totalling 50,000 to 150,000 square feet. The following are the main findings:

1. Trip generation rates for regional shopping centers were lower than those for super/hyperstores.
2. Patronage at regional centers increases from Thursday evening through Saturday.

paper also presents the idea that the two biggest deterrents to transit use are the belief that the transit market is limited to transit dependents and commuters, and
the lack of familiarity or interest in transit by people who can drive alone.

Key findings include:

1) 6.6% of shoppers at the center in December 1980 and in January 1981 use transit as access mode.
2) Several design criteria for the transit center were considered: exclusive bus access points, berth space layout and size, covered and secure waiting areas and use of facilities such as telephones and vending machines.
3) Seventeen percent of transit riders were under age 18 and nineteen percent were over age 65.

Maitland, Barry. *Shopping Malls: Planning and Design*. New York, New York: Nichols Publishing Co., 1985.

This publication deals largely with the architectural and design issues for shopping centers and speaks of walkways in downtown areas. Does not address anything concerning transportation.

Maitland, Barry. *The New Architecture of the Retail Mall*. New York, New York: Van Nostrand Reinhold, 1990.

The article talks about various design considerations of retail malls. Pertaining to the ARB study, this articles states that "vehicular access, servicing and car parking should be unobtrusive and should not disrupt pedestrian movement around the perimeter of the development." The author discusses how servicing areas have been moved from the basements of the centers, where they were originally located, to at-grade perimeter service points. However, the design concern with this scenario is that if the ground level is occupied with servicing points then the mall level may be elevated to upper floors. This creates dead store frontages. The remainder of the article deals with the design considerations of integrating the retail center within the surrounding urban context.

McKeever, Christopher, Judy W. Quon, Roberta Valdez. "Market-Based Strategies for Increasing the Use of Alternative Commute Modes." Paper number 910291 presented at the 70th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1991.

This paper studies the results of Orange County, California commuter and rideshare matching survey implemented to study the potential diversion of auto trips to carpools, vanpools, bike trips, walk trips, and public transportation. It outlines a set of demographic factors affecting the use of alternative commute modes. The paper identifies the following factors as those considered in the choice of travel mode: travel time; the need for a car before work, after work, and during the day; independence; comfort; commute costs and privacy.

Meta Information Services Opinion Research Division. *Sacramento Area Council of Governments Survey of Visitor and Employee Transportation Behaviors in the Arden Fair/Point West and Sunrise/White Rock Activity Centers*. Sacramento, California: Meta Information Services, August 15, 1991.

riders and non-riders, low income persons vs. high income persons and malls with and without existing transit service. Following is a brief summary of findings:

It was found that shoppers prefer fixed-route service over demand responsive (dial-a-ride) service. The study also indicated that if transit service were designed to match the travel desires of shoppers and employees, it might attract enough patronage to be economically attractive. A properly designed service would attract a mode split in excess of ten percent. Survey respondents felt that service should have short wait times, short walk distances, travel times comparable to that using an automobile, and low fares. They did not rate covered shelters at the malls to be an important feature.

Transit preferences are similar for both employees and shoppers, but employees are far more sensitive to waiting time and fare than shoppers. Employees tend to use transit far more than shoppers do, and their trips are generally shorter in length. In general, transit riders make and spend less money than non-riders. Non-riders have a great aversion to walking to transit, even though most reported living within four blocks of service.

Finally, transit users tend to have lower average income than non-users ($16,695 vs. $28,149), and non-users on average have greater auto availability (92.9% vs. 33.7%).

Scott, Keith. *Shopping Center Design*. London: Van Nostrand Reinhold, 1989.

This article discusses aesthetically-pleasing architectural ideas for designing parking facilities at shopping centers.

Sheskin, Ira M. "The Relationship Between Surveyed Behavioral Intent and Actual Behavior in Transit Usage." Paper presented at the 70th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1991.

This paper presents survey results assessing attitudes toward transit. Two surveys were taken in Miami, Florida, one before the opening of Metrorail and one after its opening. Actual Metrorail ridership was then compared to the estimated ridership projected from the survey data. The paper presents "a conceptual framework outlining the various types of factors that have been used to assess behavioral intent. Such research indicates that the percentage expressing positive intentions to use transit must be divided by a number between 3 and 5 to mirror actual behavior." The results of the Metrorail surveys substantiated this claim, which indicates that the use of behavioral intent questions to predict transit ridership can be reliable in the future if more research is directed in this area. This report indicates that the 3-5 rule (for every person that uses transit, 3-5 people said they intended to) is an accurate guide, even when considering populations that change from pre-transit survey to implementation of transit service.

Slade, Louis J. and F.E. Gorove. "Reductions in Estimates of Traffic Impacts of Regional Shopping Center." *ITE Journal* (5)1: 16-18(January 1981).

A traditional traffic impact analysis involves distributing trips generated by a new shopping center onto local streets and then adding those volumes to existing volumes to arrive at an estimate of traffic on local streets after the center is opened. This method is incorrect because it assumes that

3. The larger the development, the less significant the peak at the end of the week.
4. The standard parking allotment is 6.5 spaces/1000 square feet of gross leaseable area of floor space (GLA).
5. The average catchment area/trip distance is roughly 30 minutes or 12-15 miles.
6. The average stay at a regional shopping center is 1. 5 hours.

Salomon, Ilan and Frank Koppelman, "A Framework for Studying Teleshopping Versus Store Shopping," Transportation Research Record, July 1988.

"This paper develops a framework for studying the choice among modes of shopping and looks at the impact of telecommunication technologies on human travel and activity patterns." The main point of the article is that "if telecommunications-based information is competitive to information obtained through travel in quality, costs, and psychological benefits, individuals may use telecommunications for some of their shopping activities. Teleshopping may be a substitute for travel."

Shopping is defined as a store visit where information about a product is gathered and a purchase can be made. Teleshopping is defined as the options available to collect product information that do not require travel. The author illustrates how shopping fulfills two functions: 1) as a part of household maintenance, resources are exchanged for goods in the marketplace and 2) it provides an opportunity of recreation and social interaction. This paper "develops a conceptual structure that integrates a range of factors affecting shopping behavior."

Key findings include:

1) "The shopping cycle includes shopping and purchasing behavior. Shopping involves the two distinct decisions: choice of shopping strategy, which defines one or more shopping modes. Purchasing involves the decision to purchase a good or exit the market.

2) Choice of shopping mode is dependent on numerous factors which describe the product characteristics, consumer characteristics, and the alternative modes of shopping. The importance of these factors can be revealed by focusing on the behavior and attitudes of the individual. When the importance of these factors is revealed, the impact of teleshopping on behavior may be understood."

Schneider, Jerry B., Leigh McAlister, Uchila Umesh, Conrad Boyle Dulce Setterfield. *Consumer Preferences for Alternative Transit Service Concepts at Regional Shopping Centers: An Initial Assessment*. Research Report No. 81-4 (UMTA-WA-11-0008-RR81-4). Seattle, Washington: University of Washington, Urban Transportation Program (FX-10), Depts of Civil Engineering & Urban Planning, February 1982.

2070 shoppers and employees at 17 regional malls with GLA greater than 1 million square feet were surveyed to identify preferences for types of transit service at regional shopping malls. The study focused on whether geographic region, average income, the density of the area surrounding the mall and the mall serving as a major transfer center might affect the preference or lack thereof to use transit to shopping malls. The study presents data profiles on shoppers, employees, transit

to or from work. Approximately two-thirds of this shopping activity is either diverted from other shopping locations or in newly induced shopping. For the shopping centers surveyed, the average increase in sales due to the presence of park-and-ride activity is $5/park-and-ride/day. Also, the presence of the park-and-ride facility, in itself, is responsible for 10-30 percent of the park-and-riders choosing to use transit or form a carpool."

The following persons benefit as a result of establishing park-and-ride facilities:

1) The shopping center operator as long as there is adequate parking for all customers;
2) The commuter because work and shop trips are easily linked; and
3) The public agencies involved because the need for additional parking facilities is reduced as total vehicle miles traveled is reduced.
4) Park-and-ride requires more research before being a TDM candidate. If their main effect is to divert trips to/from other centers, the effect may be positive or negative depnding on VMT. For example, park-and-ride that generates new vehicle trips negatively affect air quality.

Snohomish County Transportation Authority. *A Guide to Land Use and Public Transportation for Snohomish County, Washington*. Lynwood, Washington: The Snohomish County Transportation Authority, December 1988.

This publication suggests working with the transit district to establish a standard transit shelter design. It also suggests locating transit facilities in a "shared plaza" or at a main entrance and identifies safety, efficiency (minimize loops), transfer opportunities and sight distance as important factors.

State of Florida, Department of Environmental Regulation, Bureau of Air Monitoring and Assessment. *Guidelines for Evaluating the Air Quality Impacts of Indirect Sources*. Tallahassee, Florida: State of Florida, Department of Environmental Regulation, Bureau of Air Monitoring and Assessment, January 1988 (reprinted October 1990).

This paper addresses method of modelling emissions. It does not discuss anything pertaining to the indirect sources generating the trips. It merely identifies a list of indirect sources capable of generating trips that would produce excessive emissions. These indirect sources include PUDs, office complexes, shopping centers, airports, stadiums and theme parks.

Stein, Howard S. "Parking Study of Neighborhood and Community Shopping Centers." *Transportation Research Record* 1299(1991): 19-27.

This paper describes parking demand at local-serving neighborhood and community shopping centers in Fairfax County, Virginia. It does not deal with regional centers; it looks only at local smaller centers serving local needs. The objectives of the study were to develop reasonable, accurate and easily implemented parking standards for neighborhood retail centers and to identify the base parking rate for a wide range of conditions so that a small change in the tenant composition would not affect overall parking demand at the center.

all trips to the new center are new trips. In reality, the new shopping center does not generate the demand for the goods it provides.

The traditional impact analysis method assumes that all trips to the center are primary trips. Actually, many are linked trips. Some are diverted-linked trips, while others are not diverted. This paper describes research to determine the relative share of primary trips, diverted-linked trips and undiverted-linked trips to shopping centers. The result will be used to eliminate the assignment of undiverted-linked trips to the center from adjacent highways since these trips are already on the adjacent highways. A survey taken at a regional shopping center in Washington, D.C. indicated that 35% of the trips to that center were primary trips, while 40% were diverted-linked trips and 25% were undiverted-linked trips. The findings of the study support the hypothesis that the assumptions inherent in the traditional traffic impact analysis for a regional shopping center overestimate the impacts due to traffic generated by the center, especially during the evening peak commuter period.

Smith, Steven A. "A Methodology for Consideration of Pass-By Trips in Traffic Impact Analyses for Shopping Centers." *ITE Journal* 56(8): 37-40(August 1986).

The author describes how a significant portion of shopping center trips are pass-by trips diverted from traffic already on adjacent and nearby roads. With this in mind the author outlines a methodology for estimating the impact of shopping center trips without overestimating it by failing to consider pass-by trips.

"The percentage of pass-by trips varies by the type and size of land uses being represented, the time of day, the geographic location of the site relative to the urban center, and the nature of the roadway network serving the area." The author points out that it is incorrect to reduce the trip generation rate by the estimated pass-by trip percentage because it fails to take into account the actual distribution of traffic around the shopping center site. Given this fact, the paper outlines a methodology for estimating pass-by percent impact.

Both trip generation rates and pass-by rates depend heavily on the nature of the tenants in the shopping center. There is a trend of higher pass-by percentages for smaller centers because smaller centers contain a greater proportion of convenience-oriented facilities. As a general rule, a higher trip generation rate is usually counterbalanced by a high percentage of pass-by trips. Stores featuring comparison shopping (i.e. department stores) have lower trip generation rates and are less likely to attract pass-by trips. Some data support the idea that the pass-by trip percentage can be estimated based on the size of the shopping center. The study identifies the need to design centers in the future to maximize pass-by trips instead of new trips.

Smith, Steven A. "Park-and-Ride at Shopping Centers: A Quantification of Modal-Shift and Economic Impacts." *Transportation Research Record* 908(1983): 27-31.

"The purpose of this research was to quantify the effects of park-and-ride facilities at shopping centers on commuter travel and shopping behavior. A survey of commuters at three shopping centers in Montgomery County, Maryland was conducted to estimate these impacts. The analysis demonstrated that there can be a significant economic benefit to shopping-center operators for allowing commuter parking to occur on their parking lots. Survey results indicate that between 25 and 45 percent of park-and-riders shop at the shopping center on a typical day on their way

It was found that "the arrival rate and parking duration of vehicles vary with time. It has also illustrated that a model incorporating these variations provides a better estimate of vehicle accumulation than one that uses the same duration for the entire study period."

Toth, Zoltan B., Dianne M. Atkins, Dan Bolger and Robin Foster. "Regional Shopping Center Linked Trip Distribution." *ITE Journal* 60(5): 41-46(May 1990).

"In 1987 the Transportation Department of the City of Calgary undertook a study of regional, sector, and local shopping centers to detemine the trip-making characteristics of these developments. The results of the study are intended to provide a model by which traffic patterns associated with a shopping center proposal can be more accurately predicted." The purpose of this study was to collect data on the proportion of linked shopping trips to be used in a site impact analysis and to provide information on how to distribute them with background traffic. The study provides a methodology for distributing primary trips, undiverted linked trips and diverted linked trips to shopping centers.

A diverted linked trip is a trip in which the shopping center is an intermediate stop between the origin zone and the destination zone and the trip is diverted from the original route to go to the center. An undiverted linked trip, or pass-by trip, is a trip in which the shopping center is a intermediate stop between the origin zone and the destination zone that does not require diversion from the original route to go to the center. A primary trip is a trip in which the shopping center is the only destination; the shopper returns to the origin after going to the center.

"The value of surveys that are aimed at determining the relative percentages of primary, undiverted linked, and diverted linked shopping trips can be greatly enhanced if the surveys are expanded to collect information on trips before and after the stop at the shopping center." Shopping trips are complicated for two reasons. First, a proportion of trips made are part of a series of linked trips. Second, shopping trips have a variety of origins and destinations before and after the shopping center site.

Urban Land Institute. *Dollars and Cents of Shopping Centers: 1990.* Washington, D.C.: Urban Land Institute, 1990.

This publication provides a profile (not a definition) of regional and super-regional shopping centers developed from survey data nationwide. The following information is included in the profile: average size, GLA, tenant sales, operating expenses and operating receipts. It compares the survey results by geographical region and provides operating results by age group.

Urban Land Institute. *Horton Plaza, San Diego, California.* Project Reference File (16)19. Washington, D.C.: Urban Land Institute, October-December 1986.

This paper is a description of Horton Plaza, including its history, land uses, tenant information, site design and engineering considerations dealt with during construction. Gives detailed site description.

The results of the study showed that 4.0 spaces per 1000 square feet of GLA would provide sufficient parking all year at almost all neighborhood shopping centers, regardless of factors studied. The factors studied include parking demand rates, month and day of week, restaurants, shopping center size, type of anchor store and other center characteristics. The only exception to the parking space demand comes when more than fifteen percent of the center space is devoted to restaurant use. Restaurant parking tends to exceed retail demand. The tenant mix is important, especially with regard to the percent of restaurant space.

Tebinka, Richard S. "Transit Service at Shopping Centers." *ITE Journal* 59(11): 42-45(November 1989).

This paper describes transit service to three regional shopping centers in Winnipeg, Manitoba, Canada. It identifies problems with the service and provides solutions. Problems at the Garden City Shopping Center dealt with bus service being delayed because the buses had to share the aisle with other vehicles, bus conflicts with pedestrians and customer vehicles, and buses causing pavement damage. The solution was to create a transit center, which resulted in a significant reduction in vehicle delay and conflicts. The same problems at the Polo Park Shopping Center were handled by assigning transit to specific lanes and adding new lanes and creating a transit center. The result was a reduction in conflicts and congestion for all vehicles, elimination of delays, and simplification of the routing structure.

Summary of Findings:

1) Extensive transit service at shopping centers leads to problems when buses use main aisles. Buses experience major delays as a result.
2) The transit facility should be developed as close to the shopping center entrance as possible to minimize walking distance from the bus to the center.
3) Concrete bus pads should be used at stops. Concrete or heavy-duty asphalt pavement should be used for all aisles.
4) Shopping center operators felt that transit provided positive benefits to the centers. Transit mode split at the studied centers was 25% for the P.M. peak prior to the transit center being built, and 18% for an eight hour period after the transit center was built.
5) Transit centers alone, transit lanes or lay-bys may or may not increase transit use depending on overall trends in transit for the area.

Thompson, R. and W. Young. "Determining the Parking Need and Traffic Generation of Shopping Facilities." From the Forum Papers, Volume 1, 14th Australasian Transport Research Forum, Perth, September 20-22, 1989.

This paper deals with the problem of estimating parking needs and trip generation at shopping centers. It discusses the problems arising from under-provision and over-provision of parking needs, and it "presents a general framework which aids in the planning of parking facilities and road networks at shopping centers and multi-use facilities. It includes a detailed analysis of shoppers arrival patterns and parking duration taken from surveys conducted in the Melbourne metropolitan area. In particular, the duration patterns, arrival rates of shoppers and their variation throughout the day are investigated and modelled. Using these results, a method of estimating the temporal variations in the accumulation of parkers that only requires knowledge of arrival rates is described."

APPENDIX D

Methodological Findings

Urban Land Institute. *Parking Requirements for Shopping Centers: Summary Recommendations.* Washington, D.C.: Urban Land Institute, 1981.

506 shopping centers were surveyed and parking counts were taken form 135 centers to determine the number of parking spaces required per square foot of GLA (gross leaseable area). The results apply only to centers withat least 80% of GLA allocated for retail use and apply best to centers with over 400,000 square feet of GLA. The following levels were designed for the 20th highest hour of parking demand and are adequate for all but the top 19 most congested hours of shopping during the year, at which time the shopper will probably have to look for a spot. These standards theoretically provide for surplus parking at all other times besides those 19 hours.

4 spaces per 1000 square feet of GLA for centers with 25,000 to 400,000 square feet of total GLA

4.5 spaces per 1000 square feet of GLA for centers with 400,000 to 600,000 square feet of total GLA

5.0 spaces per 1000 square feet of GLA for centers with over 600,000 square feet of total GLA

Shopping centers with a drive mode split less than 75% will require less parking. Geographic location does not significantly affect parking demand: no significant difference was found among peak parking demands at comparable centers across the country and demand was not influenced by the size of the nearest city or metropolitan area. Also, parking demand was similar for centers in the suburbs compared to urban centers. The only difference was a lower parking demand noted for centers located in a CBD and served by transit and walkways.

A major finding of the study is that peak period demand is not related to the amount of available parking, suggesting that, at least within the range of supply in the studies, parking supply alone may not be a TDM tool for reducing auto use. Also, fifteen to twenty percent of all peak period parking is taken by employees (roughly 1.6 employee spaces per 1000 square feet of GLA.

(4070/APPDX-C.FNL)

Table D-1
METHODOLOGICAL FINDINGS
(continued)

SOURCE	ITEM	TRIP PURPOSE	FINDINGS	COMMENTS
Ecosometrics, 9/80	Fare Elasticity	Shopping	-0.23 ± 0.06 Shop and school trips are generally 2 - 3 times more elastic than work	Based on 5 cities
	Service Elasticity	All	Peak: +0.33 ± 0.18 Off-peak: +0.63 ± 0.11	3 cases Vehicle miles
	Time Elasticities	All	Walk, off-peak: -0.14 Wait, off-peak: -0.21 Transfer, peak: +0.14 ± 0.18	Bus Bus and rail Bus and rail
	Transfer Elasticity	All	Off-peak: +0.59	Number of transfers
Batchelder, 10/83	Service Elasticity	All	6 cases: +0.66 ± 0.26 9 cases: +0.78 ± 0.32	Vehicle miles
	Time Elasticities	Non-work All	In-vehicle: -0.12 off-peak: -0.83 Walk, off-peak: -0.14 Wait, off-peak -0.21	1 case 1 case 1 case 1 case
	Fare Elasticity	All	Off-peak: -0.31 ± 0.16	8 cases
UMTA, 12/80	Fare Elasticity	Non-work	-0.32	
	Wait Time Elasticity	All	0.2 to 0.3	Headways < 5 minutes
Pucher, 1979	Access Cost Elasticity	Shopping	-0.32	
	Access Time Elasticity	Shopping	-0.59	
Capo & Messmer, 1987	Off-Peak Ridership	All	Ridership increase of 50%	Off-peak fare free programs

Table D-1
METHODOLOGICAL FINDINGS

SOURCE	ITEM	TRIP PURPOSE	FINDINGS		COMMENTS
TRANSIT					
UTM, 4/90	Fare Elasticity	All	Fare increase: Fare decrease:	-0.34 +0.37	14 U.S. transit systems 9 U.S. transit systems
Kemp, 6/73	Fare Elasticity	Shopping	Transit line haul:	-0.32	
			Convenience: Comparison:	-0.15 +0.34	Referred to as an anomaly by author
	Access Time Elasticity	Shopping	Transit line haul:	-0.59	
	Travel Time Elasticity	Shopping	Convenience: Comparison:	-0.65 -2.35	
Barton Aschman, 7/81	Service Elasticity	All	Increase in bus miles: Average:	+0.89	11 U.S. systems
			Peak: Off-peak:	+0.58 +0.76	30 British Cities
	Walk to Transit	All	Adjacent blocks:	35%	
	Mode Prior to Transit	All	Auto driver: Auto passenger: Walk: Other: Trip not made:	42 - 59% 21 - 22% 4 % 10% 10 - 22%	2 U.S. Cities Fare reduction and service improvement
	Fare Elasticity	All	Range:	-0.15 to -0.51	4 cities
		All	Off-peak:	-0.38	Intra-CBD, 12 free-fare programs

Table D-1
METHODOLOGICAL FINDINGS
(continued)

SOURCE	ITEM	TRIP PURPOSE	FINDINGS	COMMENTS
ACTUAL RESULTS VERSUS STATED PREFERENCE				
Sheskin, 1/91	Transit Use	All	Actual: 1/3 to 1/5 of intended	Survey taken before and after opening of Metrorail
Couture and Dooley, 1991	Transit Use	All	Actual 1/3 of intended	

(4070/TBLD-1.FNL)

Table D-1
METHODOLOGICAL FINDINGS
(continued)

SOURCE	ITEM	TRIP PURPOSE	FINDINGS	COMMENTS
PARKING				
Pucher, 1979	Out-of-Pocket Cost Elasticity	Shopping	-0.34	Based on Los Angeles data
Peat Marwick, 4/85	Short-Term Parking Elasticity	All	-0.38 to +0.93	Chicago case study
			-0.029 to -0.047	Montgomery County, $0.10/hr increased to $0.25/hr
Levine and Nohalty, 5/89	Price Elasticity	All	0 - 2 hrs: -0.03 to -2.3 0 - 3 hrs: -0.10 0 - 1 hr: -0.05 to -0.10	English cities
Olsson & Milla, 5/89	Mode Prior to Carpooling	Work	40% had used bus 38% carpooled	Discount parking for carpools
Transport Canada, 1978	Price Elasticity	Work	-0.23	Ottawa commuters
BICYCLING				
ASCE, 1980	Percent of trips by bicycle with proper facilities	Shopping	9 - 7%	Less than 2 miles Stated preference
		Personal Business and Recreation	12%	
Cambridge Systematics, 11/86	Percent of trips that would bicycle	All	Less than 6 miles: 1%	Detroit
	Percent bicycle use	Work	Daily: 14% Few times per week: 7%	San Diego Within 5 miles

APPENDIX E

Sample Questionnaire

5. *What is the:*

		Don't Know
Make	_____	☐
Model	_____	☐
Year	_____	☐

of the car, van, truck, or motorcycle in which you came to the shopping center?

[If more than one person in vehicle, ask:]

6. *Did everyone traveling with you come to the shopping center?*

☐ 1. Yes
☐ 2. No

I would now like to ask you some questions about your trip today to _____. This information will be used to improve travel to the shopping center and improve air quality.

1. *How many times have you come to this shopping center in the last four weeks, including this trip?*_____

2. *What is the primary purpose of your visit this time?*

   ☐ 1. Shopping
   ☐ 2. Personal errands (doctor visit, bank deposit)
   ☐ 3. Business errands
   ☐ 4. Eating out
   ☐ 5. Entertainment
   ☐ 6. Socializing with friends
   ☐ 7. Other_____

3. *What, if any, other purposes were there for your visit this time?*

   ☐ 1. Shopping
   ☐ 2. Personal errands
   ☐ 3. Business errands
   ☐ 4. Eating out
   ☐ 5. Entertainment
   ☐ 6. Socializing with friends
   ☐ 7. Other_____
   ☐ 8. None

4. *How did you travel here today?* **[Do Not Read List, Can Check More Than One] [Circle the last choice used]**

☐ 1. Car, van or truck Total # in vehicle _____ ☐ 2. Motorcycle/scooter	**If circled, ask questions on blue and on white pages**

☐ 3. Bus ☐ 4. Rail ☐ 5. Bicycle ☐ 6. Walk ☐ 7. Taxi ☐ 8. Other _____	**If circled, ask questions on yellow and on white pages**

9. *Where were you just before coming to the shopping center?*

- ☐ 1. Home
- ☐ 2. Work
- ☐ 3. Friend's home
- ☐ 4. Another store/shopping center
- ☐ 5. School
- ☐ 6. Other_____

10. *Where will you travel to after leaving the shopping center?*

- ☐ 1. Home
- ☐ 2. Work
- ☐ 3. Friend's home
- ☐ 4. Another store/shopping center
- ☐ 5. School
- ☐ 6. Other_____
- ☐ 7. Don't know

11. *How far in miles did you travel to reach the shopping center?*
[If hesitating]: *Give me your best estimate.*

- ☐ 1. under ½ mile (about 5 blocks)
- ☐ 2. over ½ to 2 miles
- ☐ 3. over 2 to 6 miles
- ☐ 4. over 6 to 10 miles
- ☐ 5. over 10 miles to 20 miles
- ☐ 6. over 20 miles
- ☐ 7. Don't know

12. *How long did the trip take?* _____ minutes

13. *How long will you spend at the shopping center today?* _____ hours _____ minutes

7. *Did you have a car, van, truck, or motorcycle available to you for this trip?*

- ☐ 1. Yes
- ☐ 2. No

8. *Do you have a driver's license?*

- ☐ 1. Yes
- ☐ 2. No

19. *How many persons, including yourself, live in your household (whether or not related to you)?*_____

20. *How many of these persons are children under 18?* _____
Of these, how many are under 6? _____

21. *Of the adults 18 and over, how many are currently working?* _____

22. *How many cars, vans, trucks, and motorcycles, you have available in your household?*____

23. *What is your current employment status?* **[May check more than one]**

- ☐ 1. Full-time
- ☐ 2. Part-time
- ☐ 3. Retired
- ☐ 4. Student full-time
- ☐ 5. Student part-time
- ☐ 6. Unemployed, looking for work
- ☐ 7. Homemaker
- ☐ 8. Other_____

24. *What is your age?* **[Show Card A]**

- ☐ 1. 16-17
- ☐ 2. 18-20
- ☐ 3. 21-24
- ☐ 4. 25-34
- ☐ 5. 35-44
- ☐ 6. 45-54
- ☐ 7. 55-64
- ☐ 8. 65+
- ☐ 9. Refusal

25. *What is your gross household income?* **[Show Card B]**

- ☐ 1. Less than $10,000
- ☐ 2. $10,000 to $14,999
- ☐ 3. $15,000 to $24,999
- ☐ 4. $25,000 to $34,999
- ☐ 5. $35,000 to $49,999
- ☐ 6. $50,000 to $74,999
- ☐ 7. Over $75,000
- ☐ 8. Refusal
- ☐ 9. Don't Know

26. **[Observe, do not ask]:** *Gender*

- ☐ 1. Male
- ☐ 2. Female

14. Is there is bus or light rail service available for your trip to the shopping center?

- ☐ 1. Yes
- ☐ 2. No
- ☐ 3. Don't Know

If yes:

Is it:

- ☐ 1. By bus only
- ☐ 2. By rail only
- ☐ 3. By either bus or rail
- ☐ 4. By a combination of bus and rail

15. How difficult was it to find a parking space?

- ☐ 1. Found one immediately
- ☐ 2. Found one without much trouble
- ☐ 3. Had to look awhile
- ☐ 4. It was very difficult
- ☐ 5. Don't know (was dropped off and another person parked car) **[Skip to next question]**

How long did it take? _____ minutes

16. Will you have to pay for parking here today?

- ☐ 1. Yes
- ☐ 2. No
- ☐ 3. Don't know

17. Do you expect to have your parking ticket validated?

- ☐ 1. Yes
- ☐ 2. No
- ☐ 3. Did not park in shopping center garage. Where? _____
- ☐ 4. Don't know

18. How much do you think you will have to pay to park here today? $_____

28. *If it became more difficult to find a parking space than it is right now, would you:* **[Show Card D] [Only one response can be chosen]**

☐ 1. Continue to drive to the center, and spend the time to find a parking space
☐ 2. Use another way to come to the center
[If checked, ask which way]

☐ a. bus
☐ d. walk
☐ b. rail ☐ e. dropped off
☐ c. bicycle ☐ f. other_____

☐ 3. Make fewer trips to the shopping center, but continue to purchase the same number of items (consolidate trips)
☐ 4. Shop somewhere else. Where_____
☐ 5. Park outside the shopping center and walk
☐ 6. Return to the shopping center another time
☐ 7. Other_____

29. *If a parking fee of $0.50 an hour, with no validation, were charged, would you:* **[Show Card E] [Only one response can be chosen]**

☐ 1. Continue to drive to the center
☐ 2. Use another way to come to the center **[Skip to last page Question 32]**
[If checked, ask which way]

☐ a. bus ☐ d. walk
☐ b. rail ☐ e. dropped off
☐ c. bicycle ☐ f. other_____

☐ 3. Make fewer trips to the shopping center, but continue to purchase the same number of items (consolidate trips).
☐ 4. Shop somewhere else. Where_____ **[Skip to last page Question 32]**
☐ 5. Park outside the shopping center and walk. **[Skip to last page Question 32]**
☐ 6. Other _____

27. *I'm going to read you a list of other possible ways for getting to the shopping center than by personal automobile. For each one I read, please tell me if you would be: Very Interested, Somewhat Interested, or Not Interested in using this way to shop.* (Undecided and Not Applicable are also valid answers.) **[Show Card C]**

Strategy	VI	SI	NI	U nd	NA	A	B
1. More frequent bus or light rail service	1	2	3	4	5	1	1
2. A free bus or light rail ticket for making a purchase at the shopping center	1	2	3	4	5	2	2
3. Location of bus stop near building entrance	1	2	3	4	5	3	3
4. A shuttle service from the light rail station to here	1	2	3	4	5	4	4
5 Shopper's shuttle service (e.g., to nearby worksites neighborhood and other shopping locations)	1	2	3	4	5	5	5
6. Reserved parking near building entrances for visitors and shoppers who arrive with three or more passengers	1	2	3	4	5	6	6
7. Bicycle-only lanes and storage areas that are safe and convenient	1	2	3	4	5	7	7
8. Safe, convenient, and interesting ways to walk to the shopping center	1	2	3	4	5	8	8
9. Walk to the shopping center if the distance from the street to the shopping center was shorter.	1	2	3	4	5	9	9
10. Free home delivery for packages purchased at stores in the shopping center for those who do not travel by car, van, truck, or motorcycle	1	2	3	4	5	10	10

Now here are a few ways to avoid the trip to the shopping center altogether. How interested are you in these?

11. The ability to order items by phone from stores in the shopping center, to avoid having to make the trip.	1	2	3	4	5	11	11
12. The ability to shop using a home computer to order items from stores in the shopping center.	1	2	3	4	5	12	12
					None	13	13
					Other	14	14

[If respondent traveled by car, van, truck, or motorcycle, ask:]

[Circle one answer to each question in columns above]

A. *Which of these, if any, from the list I just read to you would be the <u>most likely</u> to influence you not to come to the shopping center by car, van, truck, or motorcycle?*

B. *Which of these, if any, would be the <u>second</u> most likely?*

32. Why didn't you use transit for traveling to the shopping center? **[PROBE]**

33. Do you use transit for any purpose?

☐ 1. Yes. Describe_____
☐ 2. No.

[Check Question 11 page 4, if traveled less than 2 miles, ask:]

34. What could be provided to encourage you to walk or bicycle to the shopping center?

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30. *What about a parking fee of $1.00 an hour?*
[Show Card E] [Only one response can be chosen]

☐ 1. Continue to drive to the center
☐ 2. Use another way to come to the center **[Skip to Question 32]**
[If checked, ask which way]

☐ a. bus ☐ d. walk
☐ b. rail ☐ e. dropped off
☐ c. bicycle ☐ f. other_____

☐ 3. Make fewer trips to the shopping center, but continue to purchase the same number of items (consolidate trips).
☐ 4. Shop somewhere else. Where? _____ **[Skip to Question 32]**
☐ 5. Park outside the shopping center and walk. **[Skip to Question 32]**
☐ 6. Other _____

31. *What about a parking fee of $2.00 an hour?*
[Show Card E] [Only one response can be chosen]

☐ 1. Continue to drive to the center
☐ 2. Use another way to come to the center
[If checked, ask which way]

☐ a. bus ☐ d. walk
☐ b. rail ☐ e. dropped off
☐ c. bicycle ☐ f. other_____

☐ 3. Make fewer trips to the shopping center, but continue to purchase the same number of items (consolidate trips).
☐ 4. Shop somewhere else. Where? _____
☐ 5. Park outside the shopping center and walk.
☐ 6. Other _____

APPENDIX F

Analytical Methodology

Free Transit Ticket with Purchase

Necessary Conditions

- Transit service available

Data Required for Analysis

- Percent of trips that are shopping, eating out, or entertainment
- Percent of affected trips that are transit

Portion of Population Affected

- Trip purposes with a purchase
  - Shopping
  - Eating Out
  - Entertainment

Methodology

Percent reduction in trips = -(Elasticity of transit use with respect to cost) * (Percent of affected trips that are transit) * (Percent of trip purposes that are shopping, eating out, or entertainment) * (Percent of transit use that equals the trip reduction)

Frequent Transit Service

Necessary Conditions

- Transit service available
- Frequency of service can be increased

Data Required for Analysis

- Percent of all trips that are transit
- Percent increase in transit vehicle miles

Portion of Population Affected

- Entire population

Methodology

Percent reduction in trips = (Percent increase in transit vehicle miles) * (Elasticity of transit use with respect to service) * (Percent of all trips that are transit) * (Percent of transit use that equals the trip reduction)

Shopper's Shuttle Service

Necessary Conditions

- Comparable transit service does not exist

Data Required for Analysis

- Percent of trips within 2 miles

Portion of Population Affected

- Those traveling within 2 miles

Methodology

Percent reduction in trips = (Percent of trips within 2 miles) * (Percent likely to use shuttle) * (Percent of shuttle use that equals the trip reduction)

Location of Bus Stop

Necessary Conditions

- Transit service available
- Bus stop is not adjacent to building entrance

Data Required for Analysis

- Percent of all trips that are transit
- Distance to existing bus stop
- Distance to proposed bus stop

Portion of Population Affected

- Entire population

Methodology

Percent reduction in trips = -((Distance to existing bus stop) - (Distance to proposed bus stop))/(Distance to existing bus stop) * (Percent of all trips that are transit) * (Elasticity of transit use with respect to walk time) * (Percent of transit use that equals the trip reduction)

Reserved Parking for Carpools

Necessary Conditions

- Existing 3+ carpool share is low

Data Required for Analysis

- Average 3+ carpool size

Portion of Population Affected

- Entire population

Methodology

Percent reduction in trips = (Percent that will shift to carpools) * (1 - 1/ Average 3+ carpool size) * (Percent of carpool use that equals the trip reduction)

Shuttle to Rail Station

Necessary Conditions

- Rail or light rail station within 2 miles

Data Required for Analysis

- Percent of trips traveling over 2 miles

Portion of Population Affected

- Those traveling over 2 miles

Methodology

Percent reduction in trips = (Percent of trips traveling over 2 miles) * (Percent likely to use shuttle) * (Percent of shuttle use that equals the trip reduction)

Pedestrian Access

Necessary Conditions

- Safe and convenient walkways in surrounding area

Data Required for Analysis

- Percent of trips less than 2 miles

Portion of Population Affected

- Those traveling less than 2 miles

Methodology

Percent reduction in trips = (Percent of trips less than 2 miles) * (Percent of trips that would walk)

Bicycle Lanes and Storage Areas

Necessary Conditions

- Safe bicycle access provided on adjoining street system

Data Required for Analysis

- Percent of trips less than 2 miles

Portion of Population Affected

- Those traveling less than 2 miles

Methodology

Percent reduction in trips = (Percent of trips less than 2 miles) * (Percent of trips that would bicycle) * (Percent of bicycle use that equals the trip reduction)

Parking Pricing

Necessary Conditions

- Lack of alternative, free parking nearby

Data Required for Analysis

- Increase in hourly parking cost
- Average length of time parked
- Average roundtrip out-of-pocket costs
-

Portion of Population Affected

- Entire population

Methodology

Percent reduction in trips = -[(1 - (Percent of trips that will park outside) + (Percent of trips that will shop somewhere else)) * (Elasticity of parking demand with respect to out-of-pocket cost) * (Increase in hourly parking cost) * (Average length of time parked) / (Average round trip out-of-pocket driving costs)] + (Percent of trips that will shop somewhere else)

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Order by Phone / Computer

Necessary Conditions

- None

Data Required for Analysis

- Percent of trips that are shopping only

Portion of Population Affected

- Shopping-only trips (no secondary trip purpose)

Methodology

Percent reduction in trips = (Percent of trips that are shopping only) * (Percent of trips that would order by phone / computer) * (Percent of phone/computer ordering that equals the trip reduction)

APPENDIX G

Glossary

GLA - Gross Leaseable Area; the total retail floor space occupied by mall tenants, not including the square footage of the anchor stores.

HOV - A High Occupancy Vehicle (HOV) is a vehicle with either 2+ or 3+ occupants.

indirect sources - facilities that do not necessarily generate pollutant emissions themselves but that attract vehicle travel, which produces pollutant emissions. Examples include airports, universities, schools, hospitals, offices, and shopping centers.

ITE - Institute of Transportation Engineers, a transportation engineering professional society

linked trip - a trip with more than one trip segment; i.e. intermediate stops are made on the trip. For example, a home to work trip that includes an intermediate stop at at shopping center is a linked trip.

market population - the population located in the center's primary trade area.

mode - the type of transportation used to travel; examples include auto, transit, bicycle or walking

mode share, mode split, modal share - the percent of travel that uses a specific mode

MXD - mixed-use development, a relatively large real estate project with 1) three or more significant revenue-producing uses, such as retail, office, residential and hotel, 2) significant functional and physical integration of project components, including uninterrupted pedestrian connections, and 3) development in conformance with a coherent plan.

neighborhood/community shopping center - a shopping center with 30,000 to 100,000 (typically 50,000) square feet of GLA that serves the immediate neighborhood by providing for the sales of convenienc good (food, drugs, etc. and personal services (laundry, dry cleaning, etc.). Typically the principal tenant is a supermarket.

pass-by (drop-in) trips - Pass-by trips already exist on the roadways providing access to a facility and are made by vehicles passing by; i.e. stopping at the facility is an intermediate stop on a trip with a different purpose and destination.

pedestrian or bicycle amenities - facilities to make walking and bicycling more attractive travel alternatives. Amenities include lighted walkways, protective shelters, bike racks and lockers and separation from auto traffic.

primary shopping trips - trips from home to shopping and return to home; the main trip purpose is shopping.

regional shopping center - a shopping center with 300,000 to 750,000 square feet of retail GLA, including stores selling a variety of specialty goods, general merchandise, apparel, furniture and home furnishings. A regional shopping center is built around one to three anchor stores, each with a minimum GLA of 100,000 square feet. Centers with more than one anchor have more drawing power because they provide more comparison shopping.

SAC - suburban activity center, which is a mixed-use development typically including office, retail and residential land uses

SEC - suburban employment center, such as an office park.

SH - One of the five case studies in this project. Located in a suburban area with high surrounding densities and transit service.

SL1 - One of the five case studies in this project. Located in a suburban area with relatively low surrounding densities and transit service.

SL2 - One of the five case studies in this project. Located in a suburban area with relatively low surrounding densities and transit service.

SM - One of the five case studies in this project. Located in a suburban area with medium surrounding densities and transit service.

stated preference survey - a survey in which people are asked to rank a series of choices based upon their attractiveness. These surveys are helpful in indicating the impact of different transportation alternatives because the survey responses indicate the attractiveness of each alternative relative to other alternatives.

super regional shopping center - a shopping center with at least 750,000 square feet of GLA (typically 1,000,000+ square feet GLA) and three or more anchor department stores. Each anchor typically has 100,000 square feet GLA.

TCM - A Transportation Control Measure (TCM) is a strategy that is implemented to improve air quality. Typically TCMs involve reducing the number of vehicle trips made. TCMs are a subset of TDM.

TDM - Travel Demand Management (TDM) refers to strategies implemented to alleviate traffic demand by improving the management of vehicle trip demand. TDM strategies are focused primarily on commuter travel and are aimed at reducing the dependence on and use of single-occupancy vehicles, and at shifting peak hour trips to non-peak times. The purpose of TDM is to maximize the movement of people in the transportation system. TDM does not maximize the movement of vehicles in the system.

teleshopping - home-based shopping that does not require that a store trip to be made; such as shopping via telephone, television or other telecommunications technology

trade area - the geographic area around the center from which approximately 60 to 70% of the center's customers come

travel reduction measures - actions taken to reduce the number of trips made.

trip generation - the rate at which a facility (i.e. a shopping center) generates trips; trip generation is typically defined as the number of trips generated per unit (square feet) of space.

trip purpose - the reason why the trip is being made, typically defined in terms of the trip origin and destination, such as home-based work, home-based shopping, non-home-based, home-based other and external-external.

trip segment - each portion of a linked trip that has an origin and a destination. For example, if a person stops to shop on the way home from work, the work to home trip has two trip segments: work to shopping and shopping to home.

UH - One of the five case studies in this project. Located in an urban area with high surrounding densities and transit service.

ULI - Urban Land Institute

undiverted linked trips - These are trips in which the intermediate stop (the shopping center stop) is part of the sequence of stops within the total linked trip, and where the shopping stop does not require a major route diversion from the route that would otherwise be followed if the shopping stop were not made.

vehicle trip - a trip made in a vehicle, regardless of the vehicle occupancy.
VMT - vehicle miles traveled (VMT) is the sum of the number of vehicles traveling in a network and the number of miles each vehicle travels.

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