Southwest Region University Transportation Center

Commuter Vanpool System for Satellite Cities

SWUTC/95/465540-1

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
SWUTC/95/465540-1		

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code
Commuter Vanpool System for Satellite Cities	5. Report Date: July 1995 6. Performing Organization Code:
7. Author(s) Gregory C. Han and C. Michael Walton	8. Performing Organization Report No. Research Report 465540-1
9. Performing Organization Name and Address Center for Transportation Research University of Texas at Austin 3208 Red River, Suite 200 Austin, Texas 78705-2650	10. Work Unit No. (TRAIS) 11. Contract or Grant No. 0079
12. Sponsoring Agency Name and Address Southwest Region University Transportation Center Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135	13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

Supported by a grant from the Office of the Governor of the State of Texas, Energy Office

16. Abstract

Austin, Texas, a rapidly growing city, will have to make decisions regarding its future transportation services for residents who live outside of the central area. By the year 2010 Austin's population is forecasted to expand from today's 700,000 to about 1,112,000 which is a mid range estimate. The high range estimate is 1,363,000. Embedded in this growth forecast is the fact that most of the growth will occur outside of the central city. The forecasted growth is consistent with recent growth trends. For instance, according to the U.S. Bureau of Census, the population of the Austin Metropolitan Statistical Area (MSA) grew 40% from 1970 to 1980 and by 46% from 1980 to 1990. Again, the bulk of the growth occurred outside of the central area. The satellite cities of Buda, Dripping Springs, Lakeway, Pflugerville, and Round Rock more than doubled in population. These communities usually do not have the population density that would merit a fixed route transit service, yet a large portion of the residents in these communities commute to Austin to work. About 76% of Rollingwood commutes to Austin, 73% of San Leanna, 71% of Pflugerville, and 68% of Westlake Hills. The only convenient choice for most of these commuters is the private automobile. Because commuters are limited to using their autos to get to work, they become major contributors to the congestion problems that many cities face. Such auto dependency in Texas as demonstrated by more than 156,000 million vehicle-miles traveled in the state annually, second only to California. Congestion on urban interstates has reached peak proportions. In 1975 less than 40% of the urban interstate system had speeds averaging under 35 miles per hour, but by 1990 that proportion had risen to over 70%. Associated with the increase in automobile travel is the increase of air pollution. Both vehicles and more vehicle use contribute to air pollution.

17. Key Words	18. Distribution Statement
Vanpool, Commuter, Satellite Cities, Rideshare	No Restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	85	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

COMMUTER VANPOOL SYSTEM FOR SATELLITE CITIES

by

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Research Report SWUTC/95/465540-1

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JULY 1995

ACKNOWLEDGMENT

This publication was developed as part of the University Transportation Centers Program which is funded 50% in oil overcharge funds from the Stripper Well settlement as provided by the Texas State Energy Conservation Office and approved by the U.S. Department of Energy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

EXECUTIVE SUMMARY

The primary objective of this study is to propose a framework for analyzing and implementing a viable and self sustaining commuter vanpool system. Austin, Texas, is the target city for this study. A variety of issues concerning the viability of a vanpool system will be addressed.

The following framework was developed for analyzing and implementing a commuter vanpool system.

Step 1, *Conceptualize Vanpool System*, consists of proposing the vanpool system's organizational structure. Questions that must be answered include who pays for the system, who provides the system, how does the system work, and what equipment is used in the system?

Step 2, *Identify Employment Nodes*, consists of finding the worksites in Austin that attract large numbers of commuters. The worksites may include more than one employer. The goal of this step is to target the worksites that have the greatest potential for implementing a vanpool system.

Various sources were used to identify the major employment nodes. These were usually sites consisting of one or more employers employing a large number of employees and could be either public or private.

Step 3, *Identify Employee Residential Locations*, requires knowing where employees are residing for the identified worksites. The purpose of this step is to locate satellite cities with concentrations of workers that commute to the same worksite. This information is used to match vanpool riders.

Identifying employee residential locations required using survey data. Surveys that were performed at worksites to get commute data also usually obtained employee residential locations in the form of zip codes. If survey data were not available, the employee residential locations would have to be approximated using data from the Census Transportation Planning Package (CTPP).

Step 4, *Target Employers with Greatest Potential*, consists of assessing how likely a vanpool system will work at a certain worksite. In this step, only characteristics of the worksite and employer are considered.

Worksites that make good candidates for the implementation of commuter vanpool systems are interested in reducing work trips, have clusters of employees residing in satellite cities, and either have adequate on site amenities or are located in a downtown type area.

It was found that, in Austin, the worksites with the greatest potential for implementation of a commuter vanpool system are those employers participating in the Voluntary Trip Reduction Program (V-Trip). This was because the participants were mainly public sector organizations and have made a commitment to reducing vehicle trips. The V-Trip program in Austin is analogous to the Clean Air Act mandated Employee Commute Options (ECO) program which requires worksites of 100 employees or more to reduce their vehicle commute trips or face penalties. Because ECO only affects cities that are classified as "severe" non-attainment areas, Austin employers do not yet have the same incentive to reduce vehicle commute trips since Austin is not yet classified as a non-attainment area.

Step 5, *Determine Employee Responsiveness*, consists of evaluating employee commuting behavior to assess whether or not a vanpool system is likely to be an acceptable commute option for employees.

This step requires that the demand for a commuter vanpool system be evaluated. A stated preference survey was developed for this purpose. The task of distribution, collection, and analysis was not performed at the time of preparation of this report. However, the survey was designed and is included in this report. Also, the mode split modeling aspect of demand analysis is addressed in this report.

Step 6, *Develop Routes and Schedules*, consists of using information from step 5 and employee schedule information to customize a viable vanpool service that is attractive to commuters.

This task required exploring the applications of Geographic Information Systems (GIS) to match riders, develop vanpool routes, and develop vanpool schedules. It was concluded that GIS tools are very appropriate for this kind of analysis. A methodology for developing routes and schedules using digitized transportation networks was outlined. However, since the time and resources were not available to perform the routing, only the vanpool rider matching task was performed.

A geographic database was compiled for three worksites in Austin. Employee locations, modes of travel, scheduled start times, and other information were pooled together and used in a GIS software package called ARCVIEW to perform spatial analysis. It was demonstrated in this report that by querying employees who work at the same worksite, start work at approximately the same time, currently drive alone, and reside in the same zip code, possible vanpool parties with adequate passenger numbers could be formed.

ABSTRACT

Austin, Texas, a rapidly growing city, will have to make decisions regarding its future transportation services for residents who live outside of the central area. By the year 2010 Austin's population is forecasted to expand from today's 700,000 to about 1,112,000 which is a mid range estimate [ATS, 1994]. The high range estimate is 1,363,000 [ATS, 1994]. Embedded in this growth forecast is the fact that most of the growth will occur outside of the central city.

The forecasted growth is consistent with recent growth trends. For instance, according to the US Bureau of Census, the population of the Austin Metropolitan Statistical Area (MSA) grew 49% from 1970 to 1980 and by 46% from 1980 to 1990. Again, the bulk of this growth occurred outside of the central area. The satellite cities of Buda, Dripping Springs, Lakeway, Pflugerville, and Round Rock more than doubled in population.

These communities usually do not have the population density that would merit a fixed route transit service; yet a large portion of the residents in these communities commute to Austin to work. About 76% of Rollingwood commutes to Austin, 73% of San Leanna, 71% of Pflugerville, and 68% of Westlake Hills [US Bureau of Census, 1991]. The only convenient choice for most of these commuters is the private automobile.

Because commuters are limited to using their autos to get to work, they become major contributors to the congestion problems that many cities face. Such auto dependency in Texas is demonstrated by more than 156,000 million vehicle-miles traveled in the state annually, second only to California. Congestion on urban interstates has reached peak proportions. In 1975 less than 40% of the urban interstate system had speeds averaging under 35 miles per hour, but by 1990 that proportion had risen to over 70%. Associated with the increases in automobile travel is the increase in air pollution. Both vehicles and more vehicle use contribute to air pollution.

This report addresses this problem by proposing a framework for developing commuter vanpool systems to serve commuters residing in satellite cities who work in Austin. Major employers that are likely candidates for such systems are identified. Methodologies for vanpool demand estimation, rider matching, vanpool routing, and vanpool scheduling are explored.

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PROBLEM STATEMENT

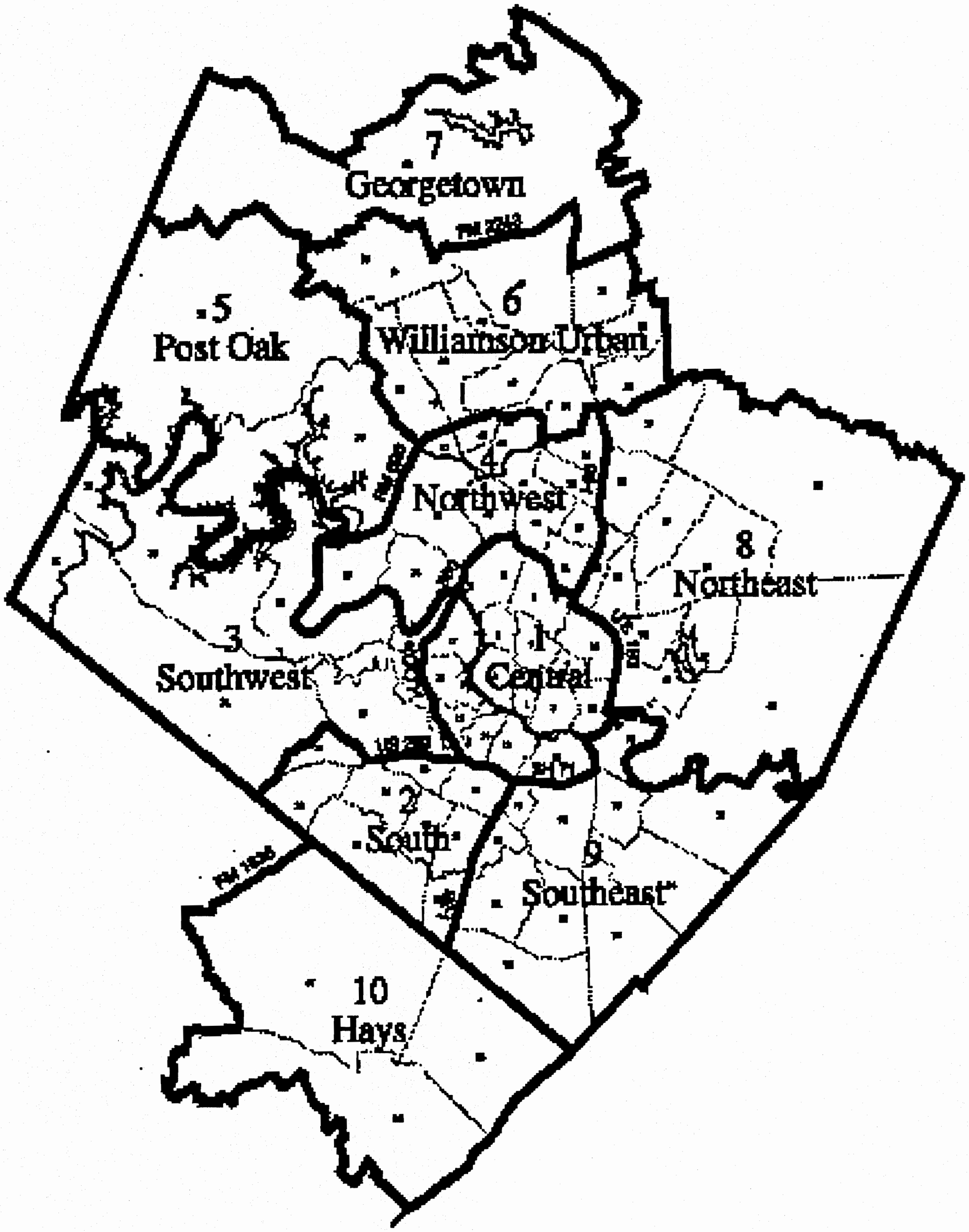
Austin, Texas, a rapidly growing city, will have to make decisions regarding its future transportation services for residents who live outside of the central area. By the year 2010 Austin's population is forecaster to expand from today's 700,000 to about 1,112,000, which is a mid range estimate [ATS, 1994]. The high range estimate is 1,363,000 [ATS, 1994]. Embedded in this growth forecast is the fact that most of the growth will occur outside of the Central sub-area. The metropolitan planning organization (MPO) for Austin, Austin Transportation Study (ATS), has divided the Austin area into sub-areas (see Figure 1) as have forecasted population growth for each sub-area. The ATS sub-areas that are forecasted to grow the most from 1994 to 2020 are Williamson Urban at 323%, Hays at 272%, Georgetown at 265%, and Northeast at 122% (see Table 1). These are the sub-areas that encompass Austin's satellite cities or hinterland communities.

Table 1: Austin's Forecasted Growth

ATS Sub-area	*Population Estimates*		*Increase #*	*Increase %*
	1994	**2020**	**# of people**	**%**
Central	304971	314688	9717	3
South	103486	119052	15566	15
Southwest	32414	57929	25515	79
Northwest	144052	171401	27349	19
Post Oak	11298	19191	7893	70
Williamson Urban	76436	323665	247229	323
Georgetown	25704	93963	68259	265
Northeast	53867	119477	65610	122
Southeast	45195	74381	29186	64
Hays	18380	68384	50004	272
Totals	815803	1362131	546328	67

Source: ATS

Figure 1: Map of ATS Sub-Areas



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These communities usually do not have the population density that would merit a fixed route transit service; yet a large portion of the residents in these communities commute to Austin to work. About 76% of Rollingwood commutes to Austin, 73% of San Leanna, 71% of Pflugerville, and 68% of Westlake Hills [US Bureau of Census, 1991]. The only convenient choice for most of these commuters is the private automobile.

Because commuters are limited to using their autos to get to work, they become major contributors to the congestion problems that many cities face. Such auto dependency in Texas is demonstrated by more than 156,000 million vehicle-miles traveled in the state annually, second only to California. Congestion on urban interstates has reached peak proportions. In 1975 less than 40% of the urban interstate system had speeds averaging under 35 miles per hour, but by 1990 that proportion had risen to over 70%. Associated with the increases in automobile travel is the increase in air pollution. Both vehicles and more vehicle use contribute to air pollution.

Need for Study

Because satellite city commuters lack a convenient alternative to solo driving, an environmentally friendly alternative must be found. Satellite cities will continue to grow as expected, and much of the demands on the present transportation system will be a result of satellite city commuters. Commuters traveling from satellite cities to some of the major employment sites can be targeted. An alternative is only viable if it can compete with the private automobile, can be economically maintained, and has interest from all the parties involved.

The proposed system in this report is an intermodal commuter vanpool system. A vanpool is where 7 or more commuters ride in a van to work during part of or the entire trip. The intermodal aspect of the system is the riders travelling from their residences to a pick up point and then taken to the work site by the van.

ATS has developed a demonstration project that parallels this proposed system. The Voluntary Trip Reduction Program, or V-Trip program, aims to reduce congestion and air pollution by encouraging employers to implement transportation demand management (TDM) techniques. Ridesharing, which includes vanpooling, is a common TDM and is included as a recommended employer measure. The proposed system in this report is compatible with the V-Trip program objectives because both aim to involve employers. Results from this and subsequent studies may aid in ATS' V-Trip efforts.

Objectives

The primary objective of this study is to propose a framework for analyzing and implementing a viable and self sustaining commuter van-pool system. Austin, Texas is the target city for this study. A variety of issues concerning the viability of a van-pool system will be addressed.

The secondary objectives address a variety of issues concerning the viability of an intermodal commuter van-pool system. These objectives are:

(1) Find the sector with the greatest potential for implementation of an intermodal commuter van-pool system.

(2) Focus on the benefits realized by a diverse group of participants, and facilitate a public/private partnership that can provide a highly efficient service.

(3) Highlight the analytical and computational tools that can be utilized in developing the service.

(4) Create a geographical commuter database that is compatible with the analytical and computational tools.

BACKGROUND

SATELLITE CITIES

Before one can analyze the characteristics of a satellite city, one must be able to define what a satellite city is. First, a few statistical definitions used by the Bureau of Census could be of use. A Standard Metropolitan Statistical Area (SMSA) is an aggregation of counties surrounding a major city which has strong socio-economic relationships to the city as well as being in the commutershed of the city. Central City is defined as being the densely populated core city which the SMSA encompasses. In some cases, there may be more than one central city within an SMSA.

Because the central city is legally defined and separated from the remainder of the SMSA, the remainder can be considered the suburbs, suburban ring, or the satellite cities. This area may have differing characteristics and development from one region to the next. For instance, in the southern and western parts of the United States, the counties are larger. This means that, because SMSAs are defined by counties, there could be suburban types of development inside what the Bureau of Census defines as the central city of a metropolitan area. However, in other areas with smaller counties, the suburbs could extend outward through several counties.

Often the satellite cities of a metropolitan region are incorporated cities. Many have coalesced with the metropolitan region to form activity centers within the metropolitan region. This growth of suburban complexes, and once-minor towns on the periphery, into economic centers has created definitional problems. A new term has arisen for this situation called *edge city*.

In the case of Austin, the whole country is experiencing rapid growth in the suburbs. The population of the U.S. expanded 56.1% during the forty years since World War II [Rosenbloom, 1990]. Metropolitan areas grew 76.1% in those same years [Rosenbloom, 1990]. This indicates that the population growth in cities has outpaced rural areas. However, central cities grew only 49.9% during those years; thus, the suburban population accounted for most of the growth [Rosenbloom, 1990]. In fact, the suburbs grew almost 200% in those years [Rosenbloom, 1990]. In 1950, 23% of the population lived in the suburbs; whereas in 1984, 44% of the population lived in the suburbs [Rosenbloom, 1990].

There are many reasons for this move to the suburbs; among them are economic advantages, choice, amenities, etc. The result of this shift in demographics is the increase in commuting flow from and within the suburbs: 83% of the increase in total commuting flow from

1960 to 1980 originated from the suburbs [Rosenbloom, 1990]. Not only were suburban commuters commuting to the central city, but also to other suburbs. A 25% increase in commuting flow from the suburbs to the central city occurred from 1960 to 1980 [Rosenbloom, 1990]. On the other hand, there was a 58% increase in commuting flow from the suburbs to other suburbs between 1960 and 1980 [Rosenbloom, 1990].

TRANSPORTATION SERVING SATELLITE CITIES

The Automobile

The private automobile is the most prevalent form of transportation in suburbia. This is due to several reasons. The convenience of the automobile is a big factor in its widespread use. There is no waiting time, and routes are not fixed, so the driver has tremendous freedom. Another reason is that owning an automobile is not difficult today. The cost of owning a vehicle is affordable for most suburban residents. Yet another important factor for the dominance of the automobile in suburbia is that land use patterns do not easily support other alternatives. Mass transit requires higher population densities in order to make them worthwhile, and ridesharing has not been promoted enough for people to realize its benefits.

The use of the private vehicle has been increasing throughout the decades according to a study by Alan Pisarski [1987]. From 1960 to 1980, private vehicle use for commuting increased from 70% to 85%. This was a doubling of 43 million vehicles in 1960 to 83 million in 1980. Along with this increase in vehicles is an increase in vehicle ownership. The majority of U.S. households own two or more vehicles today. These statistics indicate that the automobile is becoming more accessible to more people including low income groups. Over 60% of American families making under $10,000 in 1980 owned one car. In fact, about 20% owned two cars.

Two important facts regarding suburban commuting are that the majority of households without cars are central city residents and that single occupant vehicles are used for the majority of trips. This indicates that most people in the suburbs own cars and therefore are the main contributors to the congestion problems that most cities suffer. Driving alone also contributes to this problem greatly because, as vehicle ownership increases and vehicle occupancy decreases, the number of vehicles on our roads will expand at an enormous rate. The average vehicle occupancy of the U.S. is 1.15 and decreasing; thus, indicating that alternatives to the single occupant vehicle must be found in order to improve the situation [Pisarski, 1987].

Transit Services

Transit services have traditionally suffered in the suburbs. Low densities make it difficult for transit operators to provide economical transit services that can compete with the private automobile. The viability of transit services fights against suburban growth and increased car ownership so that it appears to be a losing battle.

The growing segment of suburb-to-suburb commuters has incapacitated transit service even further. According to Kasarda, "Traditional public transportation will likely be eschewed by those working in the periphery because of its spatial and temporal inflexibility and the related fact that most suburbanites desire to be in control of their movements, even at additional costs." In addition, Pisarski states that "The negative effects on transit of current trends are clear. Growth is centered where transit use is weakest- in the suburb-to-suburb market, and high levels of vehicle availability severely diminish the choice of transit." These statements suggest that as current trends continue, transit will be an even less significant alternative to the private automobile when it comes to serving suburban areas.

Transit services in general have declined in importance over the years. For instance, transit ridership has dropped 10% each decade from 1950 to 1980 [Pisarski, 1987]. In addition, transit ridership throughout the country is heavily centered in large cities. A stunning fact is that about one third of all transit travel occurs in New York City [Pisarski, 1987]. The cities with populations over one million account for 80% of all transit travel. These areas also have declined in transit ridership: a 10% decline from 1970 to 1980 [Pisarski, 1987].

Ridesharing

Of the alternatives to single occupant vehicle commuting from the suburbs, ridesharing probably has the greatest potential. Ridesharing, which could be carpooling or vanpooling, could produce such benefits as

- Lower commuting costs and reduced automobile dependence
- Reduced parking demand
- Community and societal savings

Lower commuting costs refers to savings in gas, maintenance, and the "hassles" of commuting itself. Reduced parking demand refers to savings to employers who would not have to build as much parking for their employees. Community and societal savings refer to savings in the environmental and congestion costs. Table 2 gives a more extensive view of the benefits of ridesharing and will be elaborated later.

One barrier facing ridesharing is its proper implementation. Without it, there would be no way for ridesharing to compete with the private automobile as a transportation service to suburban residents. Transportation Management Associations (TMAs) have been one organizer of ridesharing activities. A TMA is a group of employers, developers, business executives who have collaborated to deal with transportation issues. These TMAs usually participate in a number of activities including matching ridesharing workers, purchasing vans, assisting members in meeting government trip reduction mandates, financing areawide street improvements, etc. TMAs are funded by membership fees incurred by its members.

Although TMAs have been a revolutionary way of dealing with transportation problems, TMA supported ridesharing projects have not been as successful as those sponsored by individual companies. According to Cervero [1986], "Ridesharing programs are only successful when employers get directly involved. 16% of suburban office complexes have formal carpooling/vanpooling programs [Cervero, 1986]. Most have been sponsored by individual companies rather than TMAs." [Cervero, 1986].

Table 2: Benefits of Ridesharing

Commuter Benefits

Reduced hassle and fatigue from driving, especially in congested traffic

Reduced commuting cost (fuel, maintenance, insurance, parking, and vehicle ownership costs

Reduced vehicle maintenance difficulties and responsibilities

Reduced susceptibility to fuel shortages and associated difficulties such as gas lines and higher fuel costs

Increased reliability of commute, particularly in vanpools and buspools

Socializing opportunities with ridesharing acquaintances

Opportunity for riders to spend commuting time reading, sleeping, relaxing

Enjoyment of ridesharing incentives, e.g., preferential parking and freeway access

Reduced dependence on a personal automobile, and possible elimination of commute vehicle or availability for alternative uses

Reduced need to find parking or anxiety about parking

Door-to-door service (compared with public transit)

Employer Benefits

Reduced parking demand, resulting in fewer parking spaces, more usable space, less capital expended for parking areas, and less need for local parking control

Alleviation of local traffic congestion

Reduced employee tardiness and fatigue, and improved morale. Greater certainty about getting employees to work during a fuel shortage (emergency plans)

Improved security in parking lots

Reduced need for traffic control

Lower taxes for road building, traffic management, public parking, etc.

Access to expanded labor pools

Public relations boost for reducing community traffic, energy use, air pollution, and noise pollution

Improved employee morale

Compliance with ridesharing laws

Fringe benefits for employees (such as better parking for pools)

Community, State and National Benefits

Reduced peak period traffic congestion

Reduced energy use

Reduced air pollution

Reduced accident costs

Reduced parking demand

Reduced need for additional highway capacity

Source: Transportation Research Board, 1981

Carpools

Carpooling is where two or more people prearrange a trip in a private automobile. Carpooling has the potential of reducing vehicle miles traveled and other environmental costs by reducing the number of single occupant vehicles on the roads. However, because carpools are usually arranged casually, they are hard to supervise and are often unstable since parties may stop carpooling at anytime for any reason. Carpools work best where there is a high concentration of activities like jobs, schools, or special events. Some factors favoring carpooling include high parking costs, high occupancy lanes on freeways, congested freeways, lack of good transit or high fares, as well as other factors.

Parking situations at employment sites have had impacts on people's decisions to carpool. A survey of Warner Plaza's employees in Southern California indicated that 22% would carpool if they had free and preferential parking privileges [Transportation Research Board, 1981].

Vanpools

Vanpooling is where members of a group are picked up at specific points and taken to a common employment site and then taken back to the pickup points at the end of the workday by vans. Workers could either be picked up at their homes separately or all at once at a prearranged intermodal site like a parking lot of a mall. The van could be driven by a member of the vanpool who has the responsibility for the van and use of the van during non work times or by a vanpool agency driver. With a third party vanpool service an agency, which could be a ridesharing agency (RSA), provides the vanpool service for the employer.

Vanpooling is ideal for suburban areas because it is most attractive to workers who live about twenty or more miles away from their offices. Since larger distances between specific origins and destinations is characteristic of suburban areas due to lower population densities, vanpooling is only attractive to people who have to travel larger distances. This is because the time spent picking up other passengers or gathering at an intermodal site becomes acceptable when the overall travel time is long. This has been supported by empirical evidence. According to the 1978 Commuter Computer Survey in Los Angeles, vanpoolers tended to travel farther to work than other commuters. Vanpoolers averaged 72 miles round-trip; carpoolers, 45 miles; and 19 miles for all other commuters.

The Commuter Computer Survey also found some other interesting facts about vanpooling. It found that about 72% of new carpoolers were solo drivers and that 37% of vanpoolers were former solo drivers. This indicates that new vanpoolers had more prior contact with ridesharing and/or mass transit.

The survey also found that 38% of new vanpoolers joined through a personal reference, 29% joined as a result of a company presentation, and 19% from advertising. There were a number of reasons for joining as summarized in Table 3.

Table 3: Reasons for Vanpooling

Reason	*Riders (%)*	*Drivers (%)*
Not having to drive	25	
Convenience	15	
Reduced Cost	14	40
Save wear on car		36
Other	46	24

Source: Transportation Research Board, 1981

This table indicates that, although there is a large percentage of participants that had reasons other than those given, it can be seen that the riders of vanpools chose to join because of their irritation with driving rather than the cost savings.

One important fact learned from the survey was that vanpoolers were extremely satisfied with the service; giving it a 90% approval rate. The reasons for liking the service ranged from comfort to developing new friends. Former carpoolers and transit users who joined a vanpool emphasized comfort, convenience, time savings, and new friendships. On the other hand, former solo drivers valued monetary benefits more highly.

LEGISLATIVE ISSUES

ISTEA

Two important pieces of legislation relevant to satellite city commuter services are the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Clean Air Act Amendments of 1990 (CAAA). These acts provide incentives for cities to implement efficient and environmentally sound transportation services.

The idea behind the ISTEA legislation is intermodalism. According to ISTEA, "The policy of the U.S. Government is to encourage and promote development of a national intermodal transportation system" [FHWA]. Intermodalism can be described as viewing the total trip. An intermodal system focuses not only on the points of connection between modes, but also the links that connect the points. Vanpooling, where workers gather at a site and then are taken to the employment site by van, is an excellent example of an intermodal trip.

The ISTEA legislation has provided funds for the implementation of intermodal projects. Although a lot of ISTEA's focus is on freight movements, there has been a special fund set aside that vanpool projects could use. The Surface Transportation Program (STP) under ISTEA has

$23.9 billion over a six year period [FHWA, 1993]. Activities that are eligible for those funds include carpool and vanpool projects. Each state has a share of the STP funds that is proportional to the state's Federal-aid highway funding. The state must then allocate the funds in the following manner: 10% for safety construction activities, 10% for transportation enhancements, 50% by population between areas over 200,000 and the remaining areas of the state, and 30% can be used by the state in any area of the state [FHWA, 1993]. This indicates that there is ample opportunity to obtain funds which can be used to implement commuter vanpool services for satellite cities.

Clean Air Act Amendments

The Clean Air Act Amendments of 1990 bring an environmental angle into the issue of transportation services for satellite cities. Ozone pollution of the lower atmosphere is directly related to the vehicle miles traveled on our roads. This means that the more automobile usage, the worse our air quality. The Clean Air Act defines non-attainment areas as "regions—metropolitan statistical areas or larger—within the country that fail to meet federal air quality standards applicable to a variety of pollutants, including ozone (smog), carbon monoxide, sulfur dioxide, nitrogen dioxides, lead, and particulates" [CAA Law and Explanation]. Basically, these areas are target regions that are expected to improve their air quality.

These non-attainment areas also have a financial incentive to improve their air quality. Federal subsidies may be lost if the non-attainment area does not take measures to improve air quality. Also, controls could be imposed on the city by the EPA through local laws. This could also cost the city financially in lost business.

Because nearly all U.S. cities are declared non-attainment areas for one or more of the National Ambient Air Quality Standards (NAAQS) of which ozone is the most common, there should be great incentive all over the country to implement ridesharing and, specifically, vanpooling. The Clean Air Act targets automobile emissions by stating that transportation control measures (TCMs) should be adopted to reduce ozone. A number of measures are cited like expanded public transit, high-occupancy vehicle lanes, employer based transportation management plans, trip reduction ordinances, etc. Vanpooling makes an ideal TCM because one van could potentially remove up to fourteen vehicles from the road, thereby greatly reducing automobile use and improving air quality. Also, if vanpooling were implemented with other TCMs, the potential for improving air quality could be even higher. High occupancy vehicle lanes complement vanpooling because they allow vans to gain travel time advantages over single occupant vehicles; thus, giving solo drivers an added incentive to vanpool.

A specific section of the Clean Air Act Amendments of 1990 targets employers in "severe" non-attainment areas. This section, known as the Employer Trip Reduction Program (ETRP) or Employee Commute Options (ECO), requires that certain employers comply with trip reduction targets within a specific time frame or suffer penalties.

The Environmental Protection Agency has measured the levels of air pollution around the country and has classified those areas that exceed certain standards as non-attainment areas. A select few areas have been classified as "severe" non-attainment areas due to the severity of their air pollution problems. These areas are the ones affected by ECO.

The CAAA of 1990 have been around since 1990, but due to delays by state legislatures and federal regulatory authorities, only California has an ECO program in operation. The cities affected by the ECO regulations include Houston/ Galveston, New York/ Long Island, Baltimore, Chicago/ Gary, Ind., San Diego, Philadelphia/ Wilmington/ Trenton, Milwaukee, and Los Angeles.

An ECO program is a program that increases the employee's alternatives to driving alone, decreases the number of vehicles driven to and parked at company work sites, and helps reduce congestion and air pollution around the work site. These new regulations are different from past legislation in that they delegate responsibility for clean air goals to employers. Past efforts to reduce automobile emissions have failed due to increases in the total amount that Americans drive. However, a previous Southern California law cut solo commuting by 5 to 10 percent since 1990.

The specific ECO requirements are the following: organizations with 100 or more employees at a work site located in a severe non-attainment area for ozone must show that the ratio of their employees commuting during the peak period to the number of vehicles used for the commutes be 25% greater than the average peak hour occupancy rate for the area. The morning peak period in many places is taken to be 6 to 10 AM. The ratio of employees commuting to the number of vehicles used is the vehicle occupancy rate. The average vehicle occupancy (AVO) is the regional target occupancy rate based on 1980 and 1990 census data and is calculated by the state. On the other hand, the average passenger occupancy (APO) is determined by the individual organization but is the same ratio.

An ECO plan must be prepared if the computed APO is below the target AVO for the area. The plan must show how the organization plans to achieve the target AVO. Each organization must survey their employees to determine their current APO. If the APO is equal to or greater than the target AVO, the organization must prepare a maintenance plan showing how they plan to keep from dropping below the target AVO. Starting in 1996, if a regulated organization does not meet the target APO, an ECO compliance plan update must be submitted annually until the target APO is met. Some areas are imposing fines of up to $25,000 a day and criminal penalties for organizations that do not comply with the ECO regulations by November 1996.

Many affected areas require that each county have a local administrative agency to monitor compliance. Also, the affected organizations must designate a person called an Employee Transportation Coordinator (ETC) to be responsible for preparing the compliance documents. This is because, unlike most regulations, final implementation will be done by employers rather than by governmental agencies specifically responsible for the environment, transportation, or planning. Monitoring and evaluation are important in order to prove compliance with the regulations, and also because of the record keeping requirements. For example, New York ECO regulation 38.10 requires that records be maintained for at least three years from the date that they were generated.

Austin is not classified as a non-attainment area and therefore is not affected by ECO regulations. However, Austin's ozone levels are rapidly approaching the limit for attaining federal air quality standards due to the rapid population growth. This means that Austin may have just as much of an incentive to reduce vehicular commute travel as other major cities affected by ECO.

CHARACTERISTICS OF VANPOOLING SERVICES

There are many incentives that could be implemented to make a commuter vanpool service work for suburban commuters. As mentioned before, vanpool services work well in conjunction with high occupancy vehicle lanes. Also, as mentioned before, legislation has set aside funds for starting vanpool services. Also, employers may have an incentive to use these funds if given tax credits or subsidies, therefore making it worthwhile from a financial standpoint.

From an urban design standpoint, office complexes that have loading and drop-off zones for vans would make the vanpool service more efficient. Also, preferential parking could be reserved for vanpools with stalls that are wide enough to accommodate the vans. This gives the riders an extra incentive for using the service. So far, about 7% of all stalls at office parks are reserved for carpools or vanpools [Cervero, 1986].

There are numerous incentives for using a vanpool service. These are usually benefits to either the employee, employer, or the community in general. The goal is to make vanpooling an attractive option to all parties involved in order to make the program viable.

Community Benefits

As mentioned before, the main benefits to the general community from vanpooling are the reduced environmental costs, social costs, and highway and parking investment costs. The degree of the benefits depend on how large an area is affected. The larger the area and ridesharing potential, the greater the benefits to the community. Reduced vehicle miles traveled (VMT) is an important benefit because of its relation to air quality. It has been estimated that the maximum reduction in VMT made by ridesharing is around 10 percent of the peak hour VMT. Energy use also is an important concern because of the planet's dwindling petroleum supply. An optimistic prediction of fuel savings by ridesharing is 11.5 billion gallons per year [Transportation Research Board, 1981].

Employee Benefits

Employees who participate in vanpools benefit in many ways. Some benefits include reduced commuting costs, lowered maintenance responsibilities for their personal vehicles, less dependence on automobiles, more security in parking lots, having a reliable commute, less frustration over driving during the rush hour, and preferential parking.

Vanpoolers are subjected to reduced commuting costs because vanpooling is much cheaper in out-of-pocket costs than solo driving. The savings come from lower gas and insurance expenses.

Another benefit mentioned is the reduced vehicle maintenance requirements. Commuters who opt not to use their personal vehicles in order to vanpool are reducing the wear and tear on their vehicles, thus, increasing the longevity of their vehicles. This means that the average cost of maintenance is reduced and provides more out-of-pocket savings to vanpool participants.

Related to reduced vehicle maintenance is the benefit of relying less on the private automobile. The vanpool rider can decide not to buy a car or even sell an existing one because there would be less of a need to use a car for commuting purposes. Conoco, a company which has organized vanpools, "reports that 25% of its vanpoolers have realized this benefit" [TRB, 1981].

Security in parking lots is a benefit of vanpooling that is not obvious but can be important in areas with high crime rates. Groups of employees leaving together at the end of the workday reduce the vulnerability to crime. This can be especially true if the workday ends at night and there is not enough lighting in the parking lots.

Having a reliable way to commute is another benefit to employees. Because vans used in vanpool services are generally new and well maintained, there is less risk of the vehicle breaking down or not starting. This means that the employees will be punctual to work.

Another benefit of vanpooling is that riders do not have to drive during the rush hour. For many people, driving during the rush hour is frustrating and a major source of stress. Vanpooling allows riders to relax and socialize during the commute instead of fighting traffic.

Other benefits include the travel time savings from using high occupancy vehicle lanes, cost savings for tolls where applicable, and preferential parking.

Employer Benefits

Not only do vanpool services benefit the community and the employees but also employers. Some notable benefits include reduced parking costs, improved access to the employment site, improved access to employees, increased employee reliability, and improved public image.

Because vanpools reduce the number of single occupant vehicles, there is less of a demand for parking at employment sites. Employers can therefore save money by building less parking. These savings are a result of lessening the need for land purchase, construction maintenance, and taxes on new employee parking facilities. Another option for employers is to use the land saved for other purposes like additions to buildings. In the mid 1970s, six fewer spaces were needed for every vanpool formed [TRB, 1981]. This resulted in a savings of $135 per year for a surface space and $395 per year for a parking structure space. These figures include annualized land and construction costs. However, in the case of high land and construction costs, the savings could range from $200 to $1000 per year or higher for every space saved. An example of a company that took advantage of these savings is the 3M Corporation, which saved $2.5 million by avoiding the construction of 1500 spaces simply by implementing vanpools.

Another benefit of vanpooling to employers is the increased accessibility around the employment site. With fewer vehicles arriving and leaving the site, local congestion is reduced. This is also a good measure for benefiting the local community because it reduces noise and pollution that would have been imposed on nearby residents. Improved relations with the local community could give companies who use vanpools public relations boosts.

Company vanpooling has the potential of improving access to employees. Vanpools could tap labor markets that would otherwise have been ignored. Several companies have realized this benefit. For instance, the Winnebago Industries plant in Forest City, Iowa, draws 70% of its employees from out of town [TRB, 1981]. General Mills in Minneapolis and Polaroid in Boston started vanpools to make up for the lack of public transportation to their sites and thus attracted employees that would have been overlooked.

Vanpooling could play a major role when companies relocate. Vanpools could be used to retain skilled workers rather than having the company rehire and retrain new employees. A few examples of companies who did this are Erving Paper Mills of Brattleboro, Vt; Prudential Insurance of Newark, NJ; Nabisco of East Hanover, NJ; and many others.

Another benefit to companies from vanpooling is that employees tend to be reliable and punctual. A few companies have reported that their most dependable employees are their vanpoolers who are almost never late to work.

As mentioned briefly before, company public relations could be boosted by vanpooling. For instance, Chrysler and 3M have received kudos in local newspapers. Oil and utility companies can use vanpooling to show the public that they are environmentally responsible. Companies can also generate goodwill with government since vanpooling contributes to the governmental goal of reducing vehicle miles traveled.

Impediments to Vanpooling

The availability of abundant free parking has been a major roadblock in getting vanpool services off the ground. Employers do not find limiting parking an attractive option for several reasons. First, developers find that reducing parking to encourage vanpools to be a risky deal. This is because suburban office complexes are extremely expensive to build, and parking is needed to attract tenants. Second, parking is viewed as permanent whereas vanpools are not. Employers do not like the idea that vanpooling has to be constantly funded, thus, giving them the impression that there are no savings. Also, vanpools, as well as other ridesharing programs, can fold at any moment due to plunges in gas prices or other reasons, leaving the employer in a predicament if parking were not available. Third, banks have been hesitant to finance projects with below standard parking due to the perception that it would detract from the project's marketability.

Another negative aspect of vanpooling from the commuter perspective is that riders would not be able to tend to midday business if stuck at the office. This becomes inherent in situations where office settings are in outlying areas that would require a vehicle in order to get around. Sparse on-site consumer services adds to this problem. Workers who are not provided with banking and food services at the employment site certainly would rather drive to work so that a vehicle is available during the day for those purposes. There have been, however, attempts to partially rectify this problem by guaranteeing vanpool riders a ride home in case of emergencies.

There are many other impediments to vanpooling that are sometimes not that obvious, but may be important. Employers may view vanpooling as unfavorable to morale because the service may seem to be a fringe benefit to a few workers: those that live far away from the site.

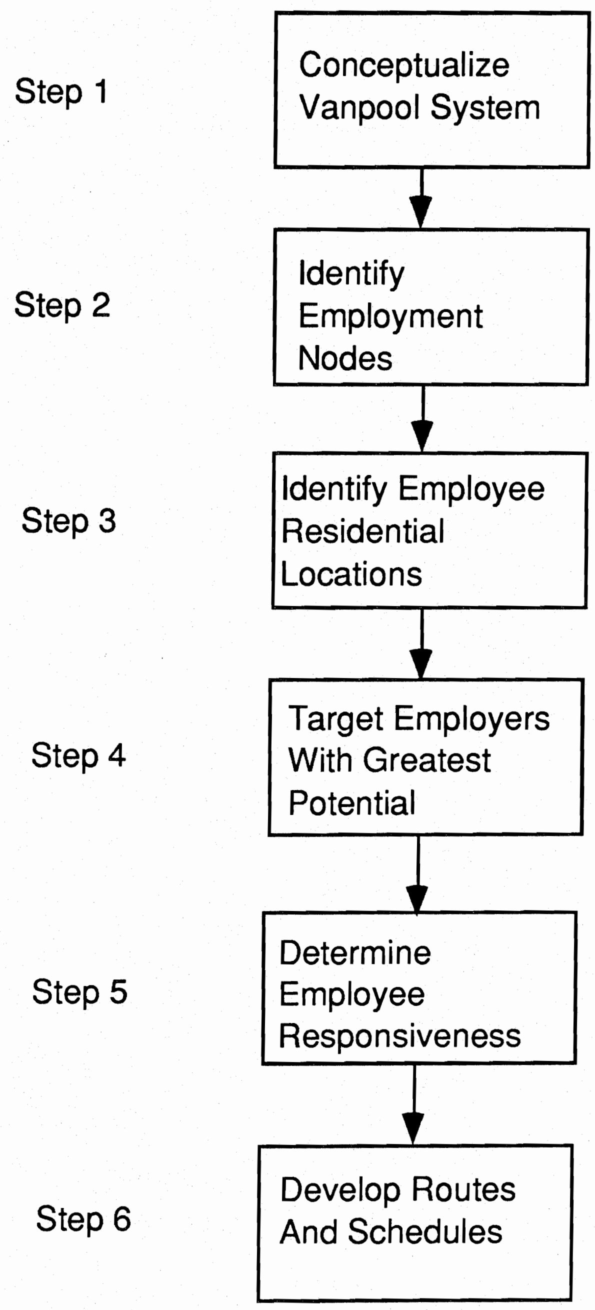
Also, employers may not want to go through the trouble of setting up a vanpool and have it fail, thus embarrassing the company. Some employers believe that vanpooling would result in unnecessary pressure on employees. Even other employers fear that vanpooling may result in losing proprietary information and staff to competing companies from the interaction and socialization during van rides.

METHODOLOGY

FRAMEWORK

Figure 2 illustrates the methodological framework that is used in developing the commuter vanpool system.

FIGURE 2: METHODOLOGICAL FRAMEWORK



Step 1, *Conceptualize Vanpool System*, consists of proposing the vanpool system's organizational structure. Questions that must be answered include who pays for the system, who provides the system, how does the system work, and what equipment is used in the system?

Step 2, *Identify Employment Nodes*, consists of finding the worksites in Austin that attract large numbers of commuters. The worksites may include more than one employer. The goal of this step is to target the worksites that have the greatest potential for implementing a vanpool system.

Step 3, *Identify Employee Residential Locations*, requires knowing where employees are residing for the identified worksites. The purpose of this step is to locate satellite cities with concentrations of workers that commute to the same worksite. This information is used to match vanpool riders.

Step 4, *Target Employers with Greatest Potential*, consists of assessing how likely a vanpool system will work at a certain worksite. In this step, only characteristics of the worksite and employer are considered.

Step 5, *Determine Employee Responsiveness*, consists of evaluating employee commuting behavior to assess whether or not a vanpool system is likely to be an acceptable commute option for employees.

Step 6, *Develop Routes and Schedules*, consists of using information from step 5 and employee schedule information to customize a viable vanpool service that is attractive to commuters.

CONCEPTUALIZE VANPOOL SYSTEM

The purpose of conceptualizing a vanpool system is to find common ground between the employers, the employees, and the transit agency. A successful system will satisfy the needs of all three. The proposed system will have the following characteristics:

1. *Be provided by Capital Metro's current vanpool service.* Capital Metro currently provides a vanpool service which is contracted from VPSI, Inc., a subsidiary of Chrysler. The vanpool service needs 10 full-time members plus a driver to be sustainable. The fares vary depending on whether the vanpool serves the Capital Metro Service area or not.

Vanpools within the Capital Metro service area are subsidized and riders pay a fare of $10/month. Riders pay on a monthly basis and commitments do not have to be long term. The driver of the vanpool rides for free but has the responsibility of taking care of the van and the paperwork. However, the van is available for the driver's personal use during the weekends with some restrictions.

Vanpools operating from outside of the Capital Metro service area are charged considerably more depending on the mileage of the commute. Table 4 outlines the fares for vanpools not operating exclusively in the Capital Metro service area as well as the estimated gasoline costs. Vanpool charges and gas costs are divided among the vanpool riders.

Table 4: Vanpool Costs for Vans Operating Outside of Capital Metro Service Area

Daily Roundtrip Mileage	*1995 Monthly Cost for 15-Passenger Van*
1-20	$845
21-40	$920
41-60	$965
61-90	$1,025
91-120	$1,080
121-160	$1,200
161-200	$1,300
	Fuel Cost
1-40	$92
41-60	$139
61-90	$208
91-120	$277
121-160	$370
161+	$375+

The vans cannot be used as a "shuttle" to bring people from one site to another several times a day, but can be used to go out for lunch and to run errands during the middle of the day.

2. *May use vans operating on compressed natural gas in the future.* Due to concerns of air pollution and over consumption of fuel, alternative fuels are being explored as substitutes to conventional fuels. Added fuel savings could be realized if the commuter vans are equipped to run on compressed natural gas (CNG).

Of all the liquid or gaseous fuels ready for conventional use, CNG offers the largest reductions in emissions compared to gasoline [California Energy Commission, 1992]. Carbon monoxide is reduced by more than 90 percent and particulates are practically eliminated.

Another benefit of CNG is that it is convenient and can be widely available. In California, an extensive network of natural gas mains delivers the fuel directly to refueling sites where compressors are installed by the local utility. Two types of fueling systems are used. First, a "quick fill" system can fuel one vehicle in two to five minutes. Second, a "slow fill" system can fuel an entire fleet of vehicles automatically overnight.

Dodge plans to build up to 2,000 CNG full-size vans. This is promising for commuter vanpool systems since CNG is currently used mainly in light duty passenger vehicles and trucks. Having a CNG van on the market will make vanpool vehicles easier and cheaper to obtain than equipping ordinary vans to operate on CNG. The savings in costs will eventually be passed down to the commuter in the form of cheaper fares.

CNG's biggest drawback is its limited range of about 120-150 miles for the average vehicle [California Energy Commission, 1992]. One solution is the Dual-Fuel vehicle that operates on either gasoline or natural gas and can switch fuels at a flick of a switch even while the engine is running. These vehicles, however, have higher emissions than vehicles running solely on CNG.

The commuter vanpool system proposed may not find this drawback a significant impact because the vans will be used as a means of everyday commuting. This kind of trip is usually a short distance compared to other kinds of trips and would not require the vehicle to have great range.

3. *Will be a park and ride type system.* Because the proposed vanpool system serves satellite city commuters that travel a large distance to get to work, a park and ride system will be utilized to minimize overall travel time. A van with 10 or more passengers would be unnecessarily delayed if the vanpool were a door to door type system. The goal is to create a system that can compete with the flexibility and travel time of the automobile.

A parking lot of a shopping center, mall, or park and ride lot will be used as the intermodal transfer point.

4. *Make use of the transit pass benefit when possible.* As a way to make the proposed vanpool system an attractive option for commuters, private employers have the ability to provide the commuter with a rideshare/transit pass. This is one of the benefits outlined by the Energy Policy Act of 1992 (102 PL 486). Section 1911 states that an employer is permitted to pay an employee up to $60/month for transit or ridesharing expenses. The employer can then fully deduct the amount from his/her gross income for Federal Tax purposes. Public organizations cannot take advantage of this benefit since they do not pay taxes.

This is a very effective way of improving the commuter vanpool system's competitiveness with the automobile because the fares can be subsidized. In the case of vanpools operating exclusively in the Capital Metro service area, the subsidized fares of $10/month can be further subsidized to be free. Vanpools operating outside of the Capital Metro service area can be subsidized with the rideshare benefit so that the fares are much more attractive.

A key to using this benefit is the employer's involvement. Employers must be made aware of this benefit and encourage employees to try alternative modes of commuting in order for the benefit to be effective.

IDENTIFYING EMPLOYMENT NODES

The data needed to perform the task of identifying major employment nodes includes a complete listing of the major employment centers in Austin and each worksite's employee count. Major employers that have the greatest vanpool participation potential are those employers that employ a large number of people. This is because the more employees an employer has, the greater the chance that there will be concentrations of employees residing near each other in the same satellite city. A vanpool requires at least ten employees to be viable as required by Capital Metro. Not every employee can be considered a potential vanpool candidate. Therefore, it is beneficial to choose the largest employers of all those possible.

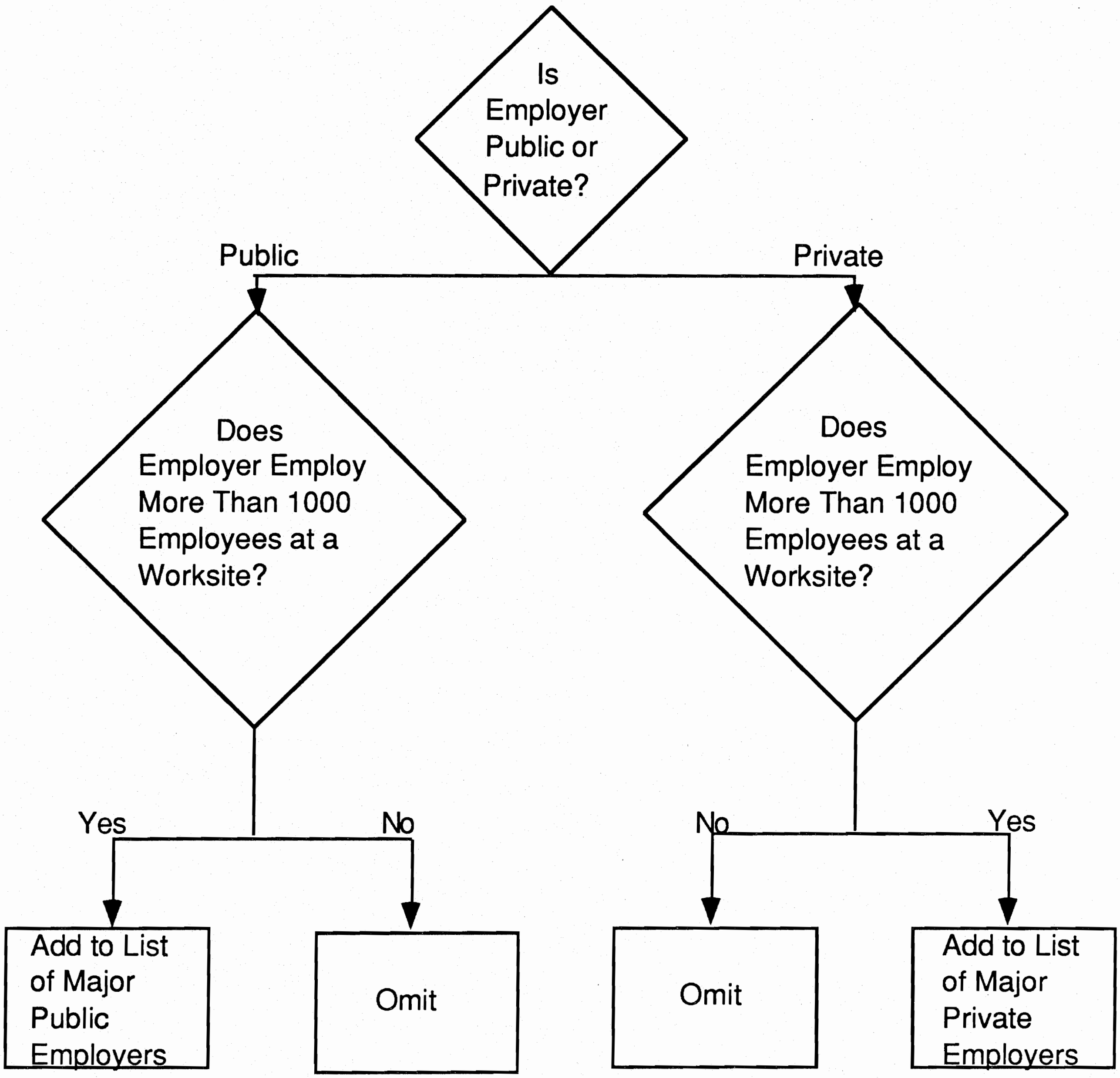
Another consideration that is taken into account is whether the worksite is comprised of several employers or just one employer. It is to our advantage to choose worksites that are comprised of a few or one employer rather than several employers. There a couple of reasons for this. First, worksites with a large number of different employers like shopping malls may have the problem of coordinating schedules that do not match. Different employers have different work policies and therefore may cause problems in matching riders. Second, communication and cooperation between many different employers is more difficult than between a few employers or between divisions of one employer. Again, different work policies may cause barriers in coordinating a vanpool service. For these reasons, the major worksites identified will mainly be those comprised of one employer.

Data sources that contain the relevant information are the Chamber of Commerce major employer listings and the "Traffic Congestion and Major Traffic Generators" listing compiled by City of Austin Public Works and Transportation Department for ATS. The Chamber of Commerce source has a listing of all the major employers in Austin and the number of employees of each. The problem with this source is that although the number of employees is given, the number of worksites is not. This means that it cannot be determined how many employees work at a single worksite. Some employers may employ a large number of people but have them distributed among several worksites. Despite these drawbacks, the Chamber of Commerce source is helpful in identifying which employers are public and which are private.

The City of Austin source is a much more reliable source because the major worksites in Austin employing more than 250 employees are located on a map. In addition, the worksite listing is broken down into two levels: the worksite and the employers. A symbol on the map represents a major work site. If the worksite is comprised of more than one employer, each employer within the worksite is identified and the number of employees per employer is given.

Two tasks are required in identifying major employment nodes. First, whether the employer is public or private should be known since financing the conceptualized vanpool system may differ depending on whether the employer can utilize the commuter pass benefit authorized by the Federal Energy Policy Act. The second thing that must be determined is whether or not the employer is considered to be a "major" employer. An arbitrary worksite size of 1000 employees is used as the cutoff for identifying major employers. Figure 3 illustrates this method of categorizing employers.

Figure 3: Method for identifying major employers



IDENTIFYING EMPLOYEE RESIDENTIAL LOCATIONS

The purpose of knowing the residential distribution of a worksite is to identify the satellite cities that have concentrations of employees for a specific employer. This information can then be used to target the satellite cities with the greatest concentrations of employees. Satellite cities with large numbers of employees commuting to the same worksite have a higher potential for implementing a vanpool service since matching riders is facilitated when there are larger numbers of employees residing within proximity of each other.

There are two different ways to obtain employee residential locations for a worksite. First, in the case where an employer has already made a commitment to reducing work trips, like those employers affected by ETRP in other cities or those participating in V-Trip in Austin, employee residential locations are best obtained through surveys. A survey is usually required for these employers in order to get information on commuting habits and to help in developing trip reduction plans. A survey is a rather reliable way of obtaining employee residential locations. There is usually a question asking the respondent to give their residential zip code or nearest major intersection. The only source of concern in this method of obtaining residential location is that not every worker will return a survey or give out his or her residential location.

Another way to obtain employee residential location is a crude one and is applicable for employers that are not interested in reducing commuting trips. In Austin, this group of employers are usually private employers. The method consists of approximating employee residential locations by the geographical distribution of work trips. The Census Transportation Planning Package (CTPP) is an appropriate data source for this method. The CTPP is a database of individual trip behavior compiled from the 1990 census' long form where certain individuals were given a more extensive survey form that obtained trip information. The information was then used to approximate the number of trips originating from a zone and arriving at another zone.

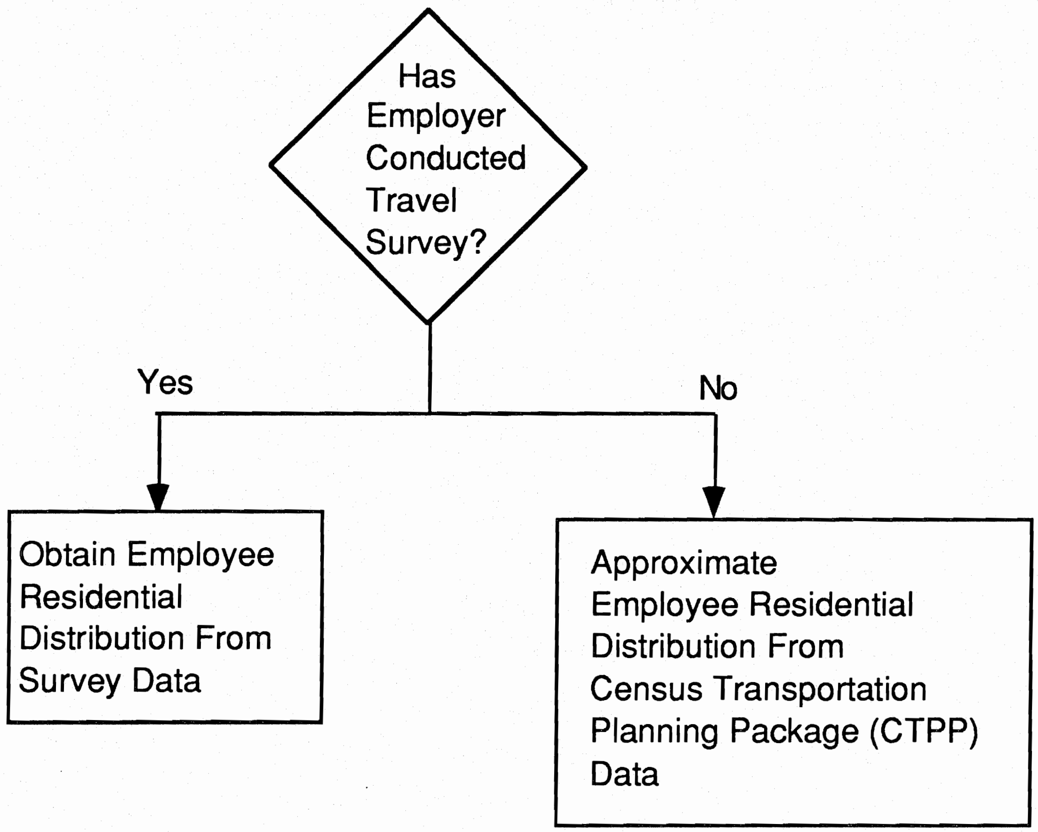
As the first step in this method, the Traffic Analysis Zone(s) (TAZ) are identified for each satellite city and employer. Then the number of work trips from the satellite city zones to the employer zones is found from the CTPP through a SAS (statistical package) program. The satellite cities with the largest number of work trips to a zone with a major employer is assumed to have a large number of the employer's workers residing in that satellite city.

There are a few sources of error in this second method. First, because the method obtains trips between zones and not trips to worksites, there may be inaccuracies if the destination zone has more than one major employer. This would mean that the number of trips to that zone could be divided among the different work destinations, thereby giving a deceptively large number of trips to the intended worksite.

Another source of error may be caused by the fact that the CTPP was compiled with 1990 data. It is not known whether the commuting patterns in Austin have remained the same or whether Austin's rapid growth has shifted commuting patterns significantly within the last five years. If the latter case is true then the error in this method could be significant.

Figure 4 illustrates the method for identifying employee residential locations.

Figure 4: Method for identifying employee residential distribution



TARGETING EMPLOYERS WITH GREATEST POTENTIAL

The criteria for an employer that has potential for implementing a commuter vanpool system are the following:

1. *Employer has clusters of employees residing in the same satellite cities.* Employers with clusters of employees residing in the same satellite city are good candidates for implementing a commuter vanpool system. This is because matching of riders is facilitated by the larger pool of likely vanpoolers. Not all employees are able to vanpool so a vanpool can best be developed for a larger group of commuters. At least 10 passengers are needed to start and maintain a vanpool; therefore, the satellite city should have at least 10 employees and preferably many more than 10.

As the commuter vanpool system expands to include several employers, it could be possible for employees commuting to different employers within close proximity to each other to ride in the same vanpool. The advantage of this stage is that an employer need not have as many employees residing in the same satellite city if other participating employers have employees residing in that satellite city. Capital Metro currently has the capability to match riders according to residential location and destination. Geographic Information Systems (GIS) also have the capability to perform vanpool matching and routing.

2. *Presence of on-site amenities.* On-site amenities play an important role in making ridesharing viable. They allow employees to be less dependent on a personal vehicle by providing services at the worksite that usually require a mid-day trip, thereby increasing the likelihood that an employee will vanpool to work. The need for on-site amenities to encourage vanpooling varies from worksite to worksite. For instance, a suburban office complex located in a low density area would need more on-site amenities to keep workers from driving to mid-day destinations than a worksite located in a bustling downtown area where mid-day destinations can be reached on foot.

Some important on-site amenities are a cafeteria, automatic teller machine (ATM), fitness center, postage, travel agency, dry cleaning, etc. These amenities provide the employee with the option of taking care of mid-day activities at the worksite rather than driving to another location. Commuters would be less likely to vanpool if they were left stranded at the worksite when they needed to tend to mid-day business. One solution to the problem of a lack of on-site amenities would be to use the vanpool van as a mid-day shuttle. The shuttle would compensate for the lack of on-site amenities by bringing ridesharers to eating establishments, dry cleaners, and other mid-day destinations. Table 5, taken from a previous study of on-site amenities, shows survey responses to the question of which amenities make the car less necessary. The table indicates that the cafeteria, ATM, and postage are the most important on-site amenities to reduce automobile dependence.

Table 5: Amenities that make the car less necessary

Amenity	Strong Agree	Some Agree	Neutral	Disagree	Strong Disagree
Cafeteria	46%	30%	12%	3%	9%
Fitness	20%	30%	35%	5%	11%
Cleaners	30%	29%	28%	4%	9%
ATM	53%	16%	21%	4%	6%
Company Store	16%	22%	46%	7%	9%
Travel agency	17%	14%	50%	4%	14%
Clinic	17%	23%	30%	3%	7%
Postage	42%	21%	29%	3%	7%

A worksite that has high potential for the implementation of a commuter vanpool system either is located within walking distance from many services, has many on-site amenities, or has an adequate combination of both.

3. *Willingness to provide support services.* A commuter vanpool service requires employers to provide support services in order for it to be successful. Some important support services pertinent to vanpoolers are preferential parking, guaranteed ride home, and supportive work policies. Preferential parking gives pooling parties an extra incentive to pool over driving alone. Guaranteed ride home programs allow commuters who rideshare to get home in case of emergencies rather than being stranded at work. Supportive work policies, like not holding meetings in the late afternoon which may run over, would allow workers to catch their rides home more easily. Also, not penalizing vanpoolers who choose not to work overtime can help carpoolers schedule their rides home.

DETERMINING EMPLOYEE RESPONSIVENESS

Demand for system

The demand for a commuter vanpool system is defined as the number of people who will use the system. The demand could be estimated by modeling individual choice between the vanpool system and all other modes available to him or her. Table A1 in Appendix A shows the variables pertinent to mode choice in this situation, the type of characteristic the variable represents, and the relationship between the variable and the likelihood of ridesharing.

There are three types of factors that affect mode choice: characteristics of the trip maker, characteristics of the journey, and characteristics of the transport facility or system [Ortuzar, 1994]. Another classification of factors that are relevant to mode choice in the situation of the commuter vanpool system for satellite cities are characteristics of the worksite. Characteristics of the journey variables are not represented in this experiment because this study targets a specific journey: the work commute from the satellite cities to employment nodes in Austin.

Only the characteristics of the system and the characteristics of the worksite variables can be altered. These variables can be changed in order to improve vanpool service and attract more riders. Characteristics of the system variables can be changed by designing a better system and usually require the ingenuity of employee transportation coordinators and transit operators. Changing the characteristics of the worksite, however, may be more difficult because it may require involvement by the employer. Employers that are dedicated to providing commute options are willing to accommodate vanpoolers. More often than not, however, the employer is not interested unless the employer is required by law to reduce vehicle commute trips.

Characteristics of the trip maker

Characteristics of the trip maker include demographical information like age, income, gender, etc. Table A1 in Appendix A indicates that there are 17 variables identified to be characteristics of trip makers and pertinent to the choice between driving and vanpooling. They are described as follows:

Children: the presence of children that are in day care has an affect on whether or not a commuter can realistically vanpool to work. Parents with young children have extra responsibility and cannot commit to ridesharing because of the extra trips needed to bring young children to day care. The only convenient option is to drive their personal vehicle.

Vehicles per number of drivers' licenses in household: This is a characteristic of the trip maker because the variable measures the availability or convenience of a personal vehicle to the individual. If the household has a vehicle for every licensed driver, then the individual is more likely to drive. On the other hand, a household with fewer vehicles per licensed driver would mean that the individual would have less access to a vehicle and therefore be more likely to vanpool.

Gender: Studies have shown that ridesharing is more common among men than women. This may be because of security issues related to sharing a ride with acquaintances who may not be familiar.

Income: Income affects mode choice between driving and vanpooling in that higher income individuals are less likely to vanpool because the financial savings from ridesharing do not play as great of a role in mode choice. Lower income individuals are more likely to vanpool because the financial savings are more important.

Age: Age may be related to the decision to vanpool in that older people who would rather not suffer the stress of driving may find vanpooling attractive.

Flexibility in schedule: Those workers that have a certain degree of flexibility in their start times may find vanpooling more attractive because the delays associated with picking up or waiting for other passengers would not cause as much of a problem compared to an individual who had a rigid start time in which case tardiness would be more of a problem.

Large number of trip chains: A trip chain occurs when an individual makes a stop for shopping or other personal business while traveling to or from work. An individual who tends to make many trip chains will not find vanpooling as attractive an option as someone who does not make as many trip chains, because vanpooling inhibits the freedom to make regular trip chains.

Need for mid-day business travel: A person who needs to make work related trips during the day will find vanpooling more of an inconvenience than a person who does not make mid-day work related trips because the lack of a personal vehicle at work inhibits the ability to leave the worksite regularly.

Environmental consciousness: An individual who believes vanpooling is an effective way for him or her to reduce pollution is more likely to vanpool than an individual that does not believe vanpooling is beneficial to the environment.

Opportunity to save wear on car: An individual who feels that vanpooling would save him or her the wear and maintenance on personal vehicles is more likely to vanpool than a person who is not concerned with saving wear on his or her own vehicle.

Opportunity not to drive: An individual who is interested in being less dependent on the automobile would find vanpooling appealing. Vanpooling allows the individual to avoid the stress associated with driving.

Increased reliability/safety of commute: Vanpool trips are safer and more reliable than driving a car because the vanpool vans are new and drivers are trained to drive defensively. Individuals who believe that this is a good reason to vanpool are more likely to vanpool than those who are less concerned with having a safer, more reliable commute.

Opportunity to socialize with vanpooling acquaintances: Commuters who would find the socializing opportunities with ridesharing acquaintances a benefit are more likely to vanpool than those who are not interested in socializing.

Opportunity to spend commuting time reading sleeping, relaxing: Individuals who are interested in spending their commutes reading, sleeping, or relaxing will find vanpooling more attractive than those who are not as interested in spending their commutes doing those things.

Reduced anxiety about parking or need to find parking: Those individuals that do not have assigned parking spaces and commute to places with limited parking may have experienced anxiety over finding parking. Individuals interested in reducing anxiety about parking will find vanpooling attractive.

Possible reduction in insurance rates on personal vehicles for vanpoolers: Some insurance companies give vanpool passengers a reduction in their insurance rates on their personal vehicles. Individuals who find this an attractive reason to vanpool are more likely to vanpool.

Encouragement by employer to vanpool: Employers may encourage employees to vanpool in order to reduce the need for parking at the worksite or for other reasons. Individuals who believe this to be a legitimate reason for them to vanpool are more likely to vanpool than those who do not.

Characteristics of the system

Characteristics of the system are attributes of the commuter vanpool service such as travel time, travel cost, and other details. The following list describes each identified variable.

Travel time: Travel time affects the commuter's decision to choose a mode. Faster travel times make the mode appear more attractive.

Travel cost: Travel cost is the fare, gas, and parking, that a commuter spends to make a trip. Modes with lower travel costs are more attractive to commuters.

Guaranteed ride home: Guaranteed ride home is a support strategy that makes vanpooling a more attractive option by allowing vanpool passengers a way to get home for emergencies. This prevents the rider from being stranded at the worksite. Vanpool services with guaranteed ride home programs are more attractive than vanpool services without guaranteed ride home programs.

Preferential parking: Preferential parking is another support strategy that makes vanpooling more appealing. Parking spots closest to the worksite reduce the walk time from the parking lot to the worksite. Vanpool programs with this privilege are more attractive than those that do not.

Walk time from parking to worksite: The walk time from the parking spot to the worksite is a component of overall travel time. Shorter walk times are more attractive than longer walk times. It may be necessary for people to walk a large distance from parking to the worksite for large complexes.

Mid-day shuttle: This is a support strategy that provides vanpool riders with the option of leaving the work premises to eat lunch, do shopping, and tend to mid-day personal business. The presence of a mid-day shuttle makes vanpooling more attractive since a personal vehicle would not be needed to make mid-day trips.

Characteristics of the worksite

Characteristics of the worksite variables are the on-site amenities that are offered at the worksite. These usually help commuters become more automobile independent. The following are the main on-site services that affect mode choice decisions.

ATM machine: An ATM machine provides the commuter with banking services on the work premises.

Cafeteria: A cafeteria allows the worker to each lunch at the worksite rather than traveling elsewhere which would often requires a vehicle.

Child care: Child care facilities offered at the worksite enable parents to bring young children directly to work with them instead of making a side trip for that purpose.

Postage: Stamps offered at the worksite allow commuters to avoid extra trips to the post office.

Dry cleaning: Dry cleaning services at the worksite allow commuters to have dry cleaning done at work rather than making a trip for dry cleaning.

Fitness: A fitness center at the worksite is an amenity for workers who like to exercise during the day.

Direct deposit: Direct deposit allows the commuter to have pay check automatically deposited.

MODE SPLIT MODEL

A model that could be used in this project for determining modal choice is a binary logit model. The model has the form of

$$\text{Prob}(B) = \frac{e^{U(B)}}{e^{U(B)} + e^{U(A)}}$$

where Prob(B) represents the probability that mode B is chosen over mode A, and U(B) and U(A) are the respective utilities of each mode.

The utility of a given mode is a numeric expression associated with the attributes of that mode as perceived by the commuter choosing between available modes. It may differ from one individual to another depending upon the emphasis one places on each attribute and the characteristics of each individual's commute. In the functional form of the utility the emphasis of an attribute appears as a weighting factor, and characteristics of a particular commute appear as the independent variables.

For our modeling purposes we used a linear utility function. Given n attributes associated with mode B its utility is

$$U(B) = k_0 + k_1 x_1 + k_2 x_2 + \ldots + k_n x_n$$

where each attribute i appears with its weighting factor and respective trip value as k_i and x_i and k_0 is the constant term.

Due to the exponential form of the probability it may be simplified as

$$\text{Prob}(B) = \{1 + \exp[U(A) - U(B)]\}^{-1}.$$

This shows that for a binary model it is only the difference in the utilities that determines the probability that one mode will be chosen over another.

In the binary model, the two choices for commuting to and from work are mode R, ridesharing (carpooling and vanpooling), and mode C, driving by car alone or with a family member. The goal of the study is to reduce vehicle usage by offering a competitive transportation system. Because a vanpool system may not be realistically implemented for certain areas, (i.e., areas that do not have enough interested riders), choice R includes carpooling. Carpooling is defined in this case as driving with an acquaintance rather than with family members. The challenge is to match riders who would normally drive alone. The variables for vanpools apply for carpools. The difference between vanpooling and carpooling, therefore, is that the carpool vehicle is smaller than a vanpool vehicle.

For each mode we used a linear equation for its utility function as described earlier. All of the characteristics affecting mode choice listed in the previous section can be represented in the utility functions as variables. Table A1 in Appendix A lists all of the considered variables, their respective utility equation, and relationship to the probability of ridesharing.

The following equation, the logarithm of the ratio of the probabilities of choosing a mode, is the difference of the utility functions and can be regressed using computer statistical packages to obtain the coefficients, k's, in the utility functions.

$$\ln \frac{\text{Prob}(C)}{\text{Prob}(R)} = U(C) - U(R)$$

At this point the mode choice model is calibrated and ready to be applied for various scenarios. The characteristics of the system can be altered in order to predict the demand for each mode. The next step would be to develop the routes, schedules, support services, and other details necessary to obtain the desired demand.

STATED CHOICE PREFERENCE SURVEY DESIGN

A stated choice preference survey was designed to obtain the necessary information to calibrate the binary logit model presented previously. The survey will be distributed to major worksites around Austin. As many employment sites should be surveyed as possible in order to obtain data that is robust. It is easier to obtain robust employee data since individuals are different from each other. However, getting robust employment site data may be difficult. More employment sites with differing characteristics is desirable. Worksites situated in different kinds of developments and with different on-site services should be surveyed in order to obtain worksite data that is robust. Robust data will result in efficient coefficient estimation from the regression of the logit model.

The goal of a stated choice preference survey is to calibrate a mode split model using individual choice responses between different hypothetical alternatives. Each alternative is represented as a set of different attributes. In the case of this experiment, there are two alternatives: to use the present mode or to rideshare to work. The present mode is a real alternative and the rideshare mode is a hypothetical mode.

The survey captures variables representing the characteristics of the trip maker and characteristics of the system. Characteristics of the trip maker are obtained by asking questions that are clear and concise. Units common to the everyday person are used to facilitate survey response.

Characteristics of the system do not exist for the hypothetical mode but do exist for the current mode. Characteristics of the current mode are obtained from straightforward questions. However, characteristics of the hypothetical situation are fixed for various scenarios. The respondent then has to compare the characteristics of the hypothetical situation with his or her current travel attributes to choose one option. The attributes of the survey experiment allow the respondent to distinguish one alternative from another. The attributes also specify the utility functions used in the logit model.

The stated choice preference survey instrument developed for this experiment is located in Appendix B. Table 6 summarizes the purpose of each question. Questions 1 through 21 obtain information to either calibrate a mode choice model or to obtain work schedule and residential location information for a geographic database which will be explained in the following sections.

Table 6: Description of Survey Questions

Survey Description	
Question number	Description/Reason
I. Travel Characteristics	
1	To get current mode of travel in order to target solo drivers
2	Get travel time for model
3	To get travel distance to calculate gas costs which is part of travel cost
4	To get walk time for model
5	To get parking cost component of travel cost
6	To get travel cost if bus were used
II. Socio-Economic Characteristics	
7	To get worksite of employee
8	Approximate location of residence. Could be used in GIS databases
9	Another source of residential location. Zip codes link databases
10	To get income of respondent for model
11	To get age of respondent for model
12	To get sex of respondent for model
13	To get work schedule information
14	To obtain schedule flexibility for model
15	To get work schedule information
16	To get children variable for model
17	To calculate veh/#licenses
18	To calculate veh/#licenses
19	To obtain trip chain variable for model
20	To obtain mid-day business variable for model
21	To obtain vanpool benefits variables for model
III. Choice Experiment	To get choice observations to calibrate mode choice model

Section III of the survey is the stated preference experiment. Five attributes of the hypothetical rideshare system have been identified as those attributes that can be realistically altered. These are rideshare cost, rideshare travel time, presence of a mid-day shuttle, existence of a guaranteed ride home program, and preferential parking. The mid-day shuttle attribute has two levels: yes, meaning it exists, and no, meaning it does not exist. The rideshare cost has three levels: high, medium, and low. These three levels represent different possible fares that could be charged to a passenger. The rideshare travel time attribute is presented as the added travel time of picking up passengers and waiting for the ride. There are three levels of rideshare travel time: faster, in-between, and slower. There are two levels for the guaranteed ride home attribute: yes (exists) and no (does not exist). Similarly, there are two attribute levels for preferential parking: yes (exists) and no (does not exist).

The number of possible combinations is calculated by taking the number of attributes, a, to the power of the number of levels, n. In this case, three attributes have two levels and two attributes have three levels. The number of combinations therefore is $3^2 2^3 = 72$.

Because it is too tedious for a survey respondent to compare 72 different situations with his or her current commuting situation in order to choose between the two alternatives, Section III of the survey is broken into four different sets of 18 scenarios. Each survey will have either choice experiment A, B, C, or D attached at the end of the same survey. This is justified because stated choice surveys are efficient in that many observations are obtained through one survey. Eventually all of the choice observations will be grouped together in order to calibrate a mode split model. Table B1 in Appendix B illustrates the attribute levels and the 72 different scenarios.

DEVELOPMENT OF ROUTES AND SCHEDULES

The development of the schedules and routes of the commuter vanpool system requires utilizing several innovative tools. A GIS software package like ARC/INFO can be used to match riders, design routes, select intermodal park and ride sites, and simulate traffic conditions. Data from surveys that obtain information on employee residential location, employee start times, current mode of travel, as well as other demographical and trip behavior information, can be compiled into a geographic database. Powerful analysis can be performed on the geographic database using ARC/INFO.

The specialized product that provides network modeling capabilities to PC ARC/INFO is called PC Network. PC Network allows for the realistic simulation of networks.

Networks

A network is defined as "a system of connected linear features through which resources flow" [PC Network User's Guide]. The movement of resources through the network is affected by the characteristics of the network. For instance, the movement through a road network is impeded depending on traffic conditions, type of road, speed limit, traffic control devices, etc. These and other factors could be modeled in a network to simulate real life conditions.

The following elements describe a network:

Links: links of a network are represented as arcs and allow for the movement of resources through the network. In real life, links are street and highway segments. The flow of resources is the flow of vehicles. Links could either be one-way or two-way.

Turns: turns are movements that vehicles can make at a node where links connect. An impedance can be associated with a particular turn. For example, a left turn that takes more time to make is an impedance. Also, certain turns may be restricted as in the case of "no left turn" intersections.

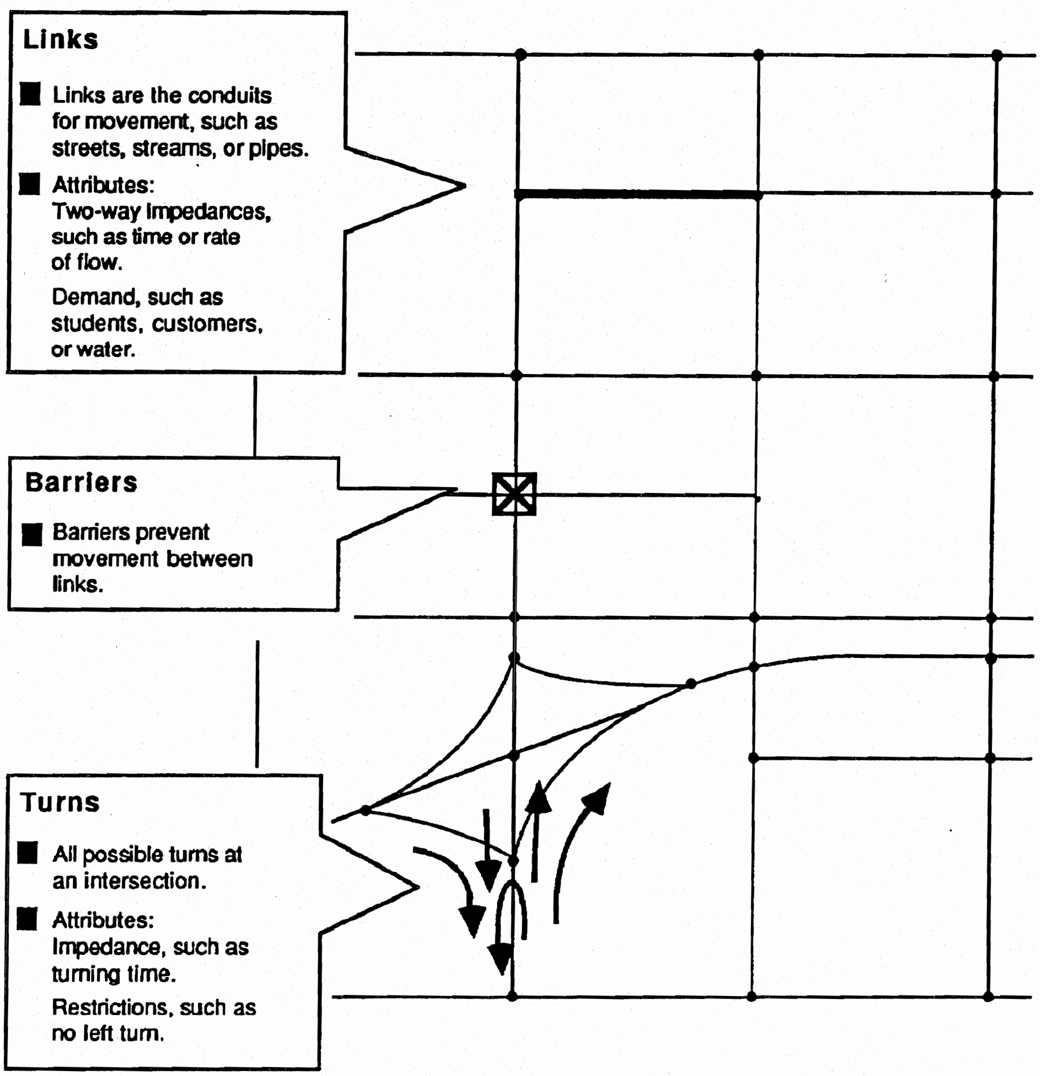
Stops: stops are nodes where resources are picked up or dropped off. For example, bus stops where passengers board or unboard are represented as stops.

Centers: centers are locations that receive or distribute resources. Employment sites could be represented as centers since they attract work trips.

Barriers: barriers are node locations that do not allow resources to flow through. They can represent accident locations, construction locations, closed off roads, etc. in a road network. Figures 5a and 5b summarize these network elements.

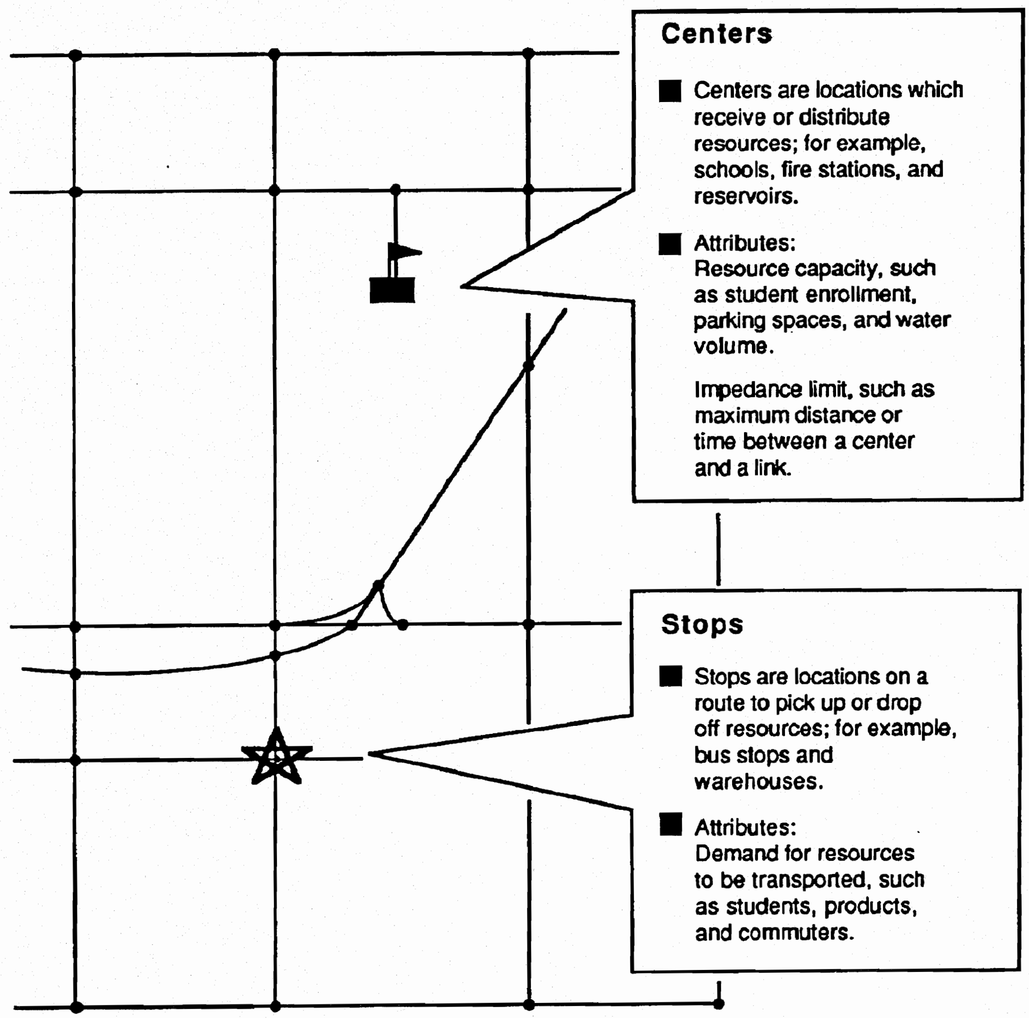
Figure 5a: Network Attributes

Elements in a network:



Source: PC Netowork User's Guide

Figure 5b: Network Attributes



Source: PC Network User's Guide

Databases

Where does one obtain a network coverage? Network coverages can be created by converting existing digital data or by inputting the network directly using ARC/INFO input procedures. Existing digital data sources include TIGER/Line files, GBF/DIME files, and ETAK MapBase files. These sources contain not only the line features but also address ranges for the left and right hand sides of each street.

The network coverage obtained from existing digital data sources may not represent transportation network characteristics realistically. Directional impedances can be added to the coverage to make travel times along certain links more realistic. The travel time required to traverse each link can be calculated or assigned by the user. Travel time can be calculated knowing the length of the link and speed limit.

Turn information can be added to the network coverage to make it even more realistic. A "turntable" is used to describe turn impedances and turn restrictions. All possible turns are identified in the table and turn impedances can be calculated or assigned. Different turn impedances can be assigned for trucks and cars.

To do useful analyses, more data than simply the network is needed. For example, locations of employers are useful information for analysis purposes. This information could be geocoded into the network coverage. Geocoding refers to building database relationships between addresses and coverage features. If addresses of employers are known, their locations could appear as points on the network coverage after geocoding. In addition to employer locations, employee locations are needed to perform analysis on the commuter vanpool system.

Network Analysis Tools

A very powerful tool is the ROUTE program. ROUTE is a path finding program that models resource movement between two or more points. The path is controlled by specifying the origin, destination, and any intermediary stops. ROUTE then finds the optimal path between the origin and destination.

ROUTE can be used to develop the vanpool routes. The commuter vanpool system would benefit from having the shortest possible travel times since travel time is a factor influencing mode choice. ROUTE could be used to find optimal paths for various traffic conditions. Different routing scenarios could simulate hypothetical situations like accidents, congestion, weather conditions, flooding, added stops like day care or dry cleaning, etc.

Another useful tool is the ALLOCATE program that performs allocation analysis. ALLOCATE assigns links and nodes to the closest center. For example, a vanpooling employee could be assigned to the closest park and ride lot based on the travel times to all possible park and ride lots. This type of analysis is useful in developing the most efficient intermodal vanpool system where a commuter must drive to the intermodal park and ride transfer site. The riders could first be assigned to the closest park and ride lot with the ALLOCATE program and then the quickest path from the park and ride lot to the worksite could be found using ROUTE.

Another feature of ROUTE is the ability to keep track of resource movement. This means that the net amount of passengers picked up or dropped off can be kept track of. Because vanpool vans have a finite capacity of approximately 15 persons per van, this feature is helpful in ensuring vanpool demand is met while still maintaining system efficiency, especially in cases where many stops are made.

Framework for forming vanpools, schedules, and routes

Figure 6 illustrates the framework for forming vanpools, developing routes, and developing schedules.

1. Digital data needs to be obtained in order to create a network coverage. These could be TIGER or GBF/DIME files.

2. Employee and employer data can be obtained through surveys. Employer data may include addresses of worksites, number of employees, available parking, and other information that may be useful to have in a database. Employee data may include residential locations, work schedules, demographic information, etc. Also, it is essential to have information on whether an employee is a prospective vanpooler or not. This can be simulated using a mode split model and data obtained directly from the survey, or individuals can be asked directly whether they are interested in vanpooling. In addition, information on whether an employee is willing to become a vanpool driver is helpful in determining how many vanpools can be created.

3. Turn impedances, turn restrictions, and directional impedances are necessary to model realistic traffic conditions. This task is an arduous one in that transportation networks are rather large and considerable time and research is needed to ensure that impedances are accurate.

4. Geocoding the employee and employer data represents the data spatially. Therefore, employee residences and worksite locations can be related to the network coverage and combined into one database.

5. Choosing park and ride locations depends on several factors. Physically, a park and ride location can simply be a parking lot that is large enough to accommodate the parked vehicles while being a safe transfer site. Other considerations, such as legal and administrative issues, must be taken into account. Vanpools may use Capital Metro's park and ride locations. However, more study is necessary to determine whether permission is needed for a vanpool to use a private shopping center's parking lot.

6. The ALLOCATE program is used to assign vanpooling commuters to their closest park and ride lot.

7. The ROUTE program is used to find optimal paths from employee residences to the park and ride lot.

8. In order to match riders, vanpoolers assigned to the same park and ride lot must be queried by work schedule. Figure 7 illustrates the subset of vanpoolers with common route and schedule.

Figure 6: Framework for forming vanpools

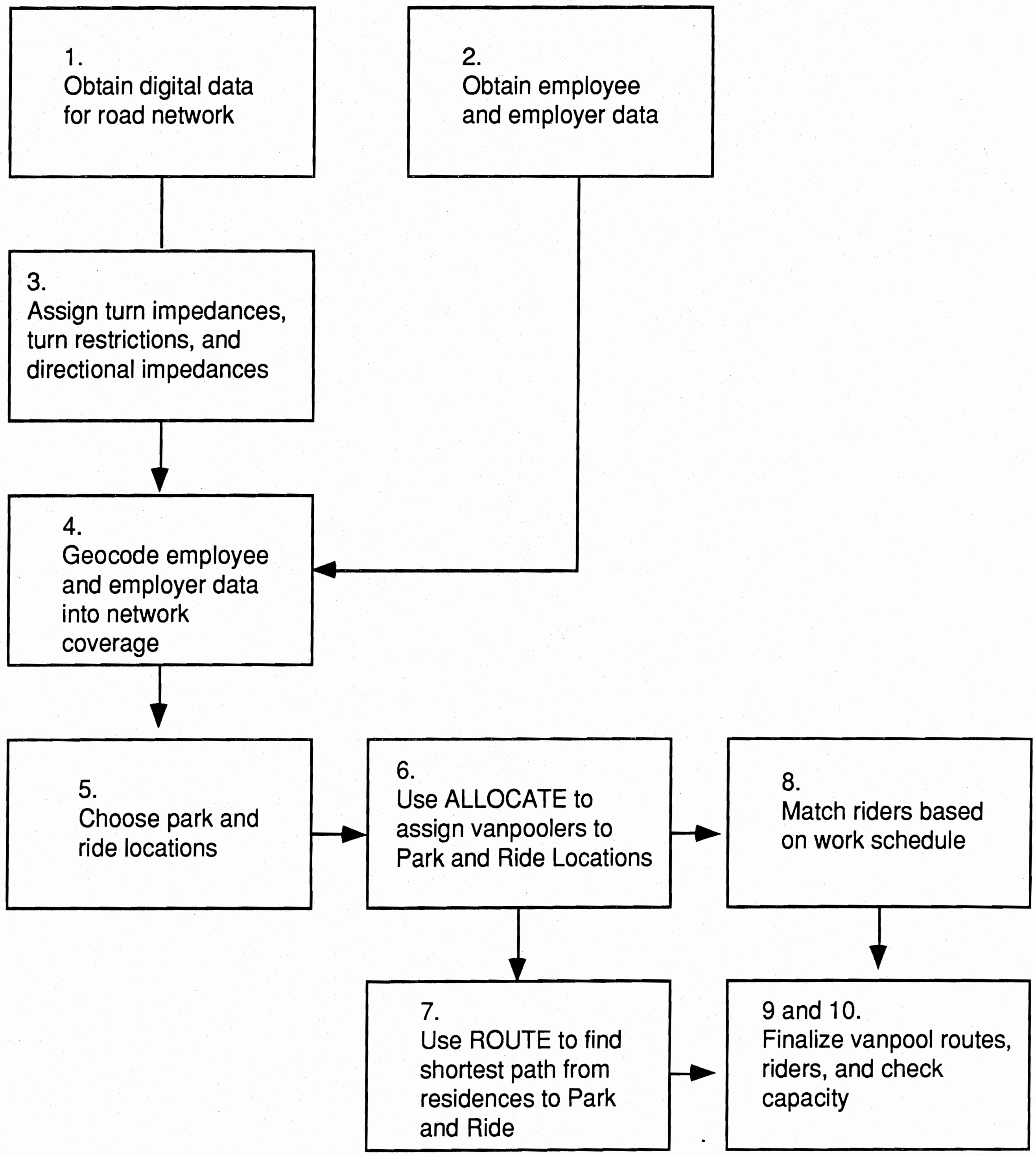
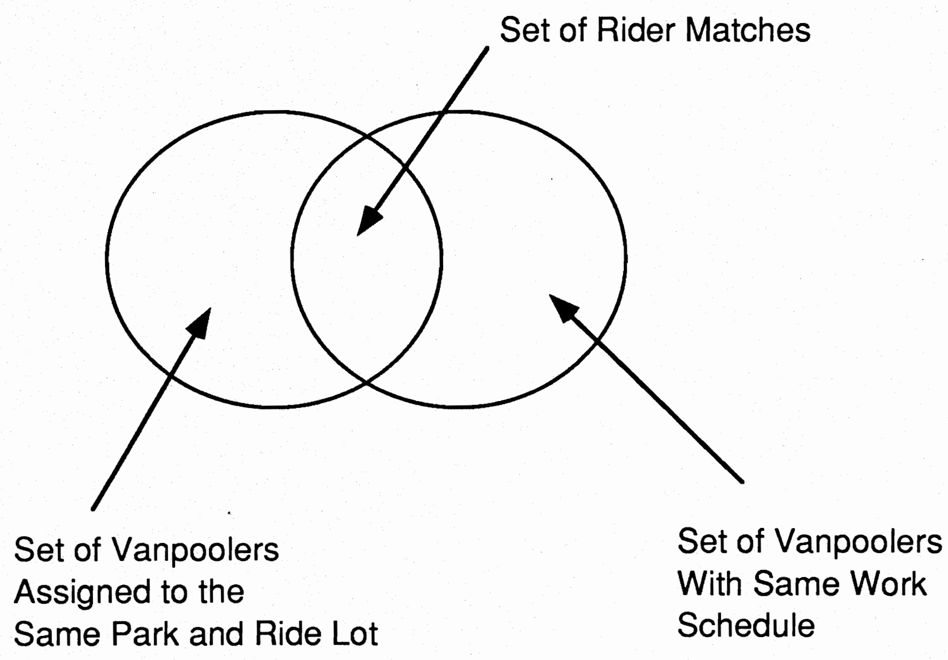


Figure 7: Vanpool subset with common route and schedule

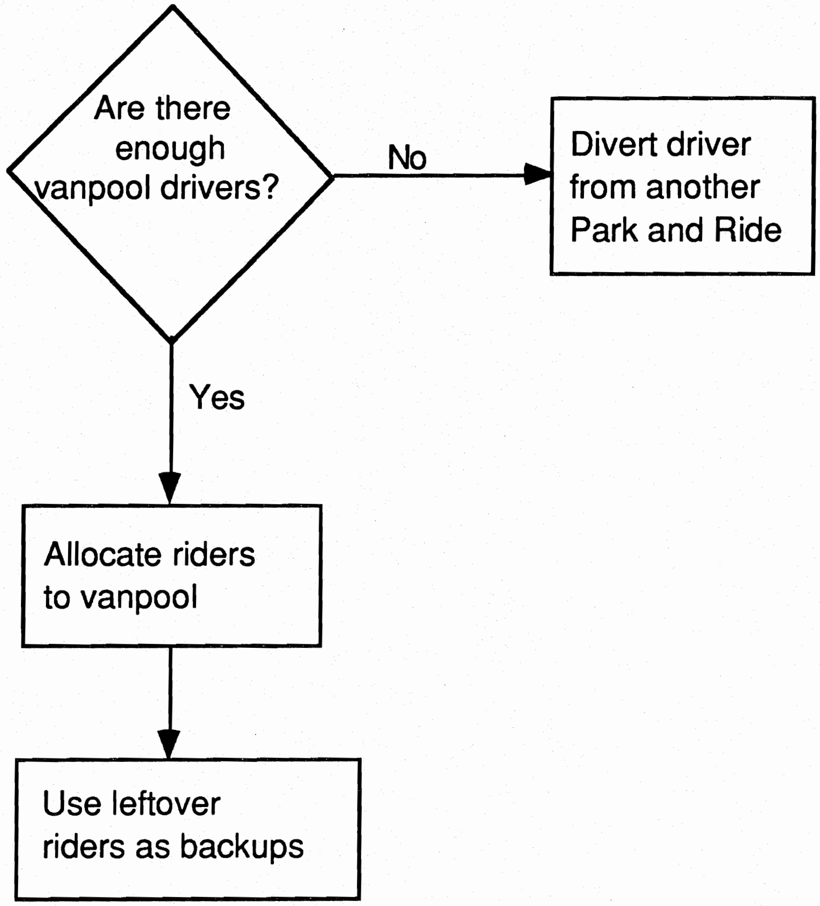


Vanpool riders having similar work schedules: similar days worked, start, and end times are matched.

9. ROUTE is used to find the shortest paths from the park and ride facility to the worksite.

10. Develop vanpool system using route and schedule information. Step 8 provides schedule information since riders with the same schedules are matched. Steps 6, 7, and 9 provide routes and transfer points. All that is left is to check to see that there are enough vanpool participants that are in the set of matched riders that are willing to drive vanpools. If there are vanpool drivers, the vanpool riders are then allocated to the available vanpools. Leftover riders that are not allocated to a vanpool can be considered backup riders in case a vanpooling member discontinues to vanpool. If there are not any vanpool drivers then a driver from another park and ride lot with a similar schedule must be diverted. Figure 8 illustrates the process of organizing vanpools.

Figure 8: Organizing vanpools



RESULTS

EMPLOYMENT NODES IDENTIFIED

Figure 9 and 10 identifies the major employment nodes in Austin. These include both public and private employers. Also identified are complexes that include several employers. Table 7 lists the major private employers around Austin and their respective numbers of employees. The actual names of these employers are not revealed in this report for proprietary reasons. The public organizations considered in this report are the ATS V-Trip participants listed in Table 8.

Table 7: Major Private Employers

Company/ Worksite	#employees	Traffic Analysis Zone (TAZ)
Organization 1	7000	201
Organization 2	5000	214
Organization 3	4400	398
Organization 4	4400	62
Organization 5	2800	484
Organization 6	2000	183
Organization 7	1700	378
Organization 8	1500	167
Organization 9	1500	493
Organization 10	1350	498
Organization 11	1250	538
Organization 12	1000	214

Source: Chamber of Commerce and author

Table 8: Public Organizations participating in V-Trip program

Organization	Worksite(s)	Number of Employees at Worksite
Texas Dept. of Transportation	All Austin locations	15349(total for all locations)
City of Austin- Dept. of Public Works and Transportation	One Texas Center(OTC)	600
City of Austin- Environmental and Conservation Services	Two Commodore Plaza (TCP)	983
Texas Natural resources Conservation Commission	Austin location	1500

Figure 9: Major Employment Nodes in Austin Area

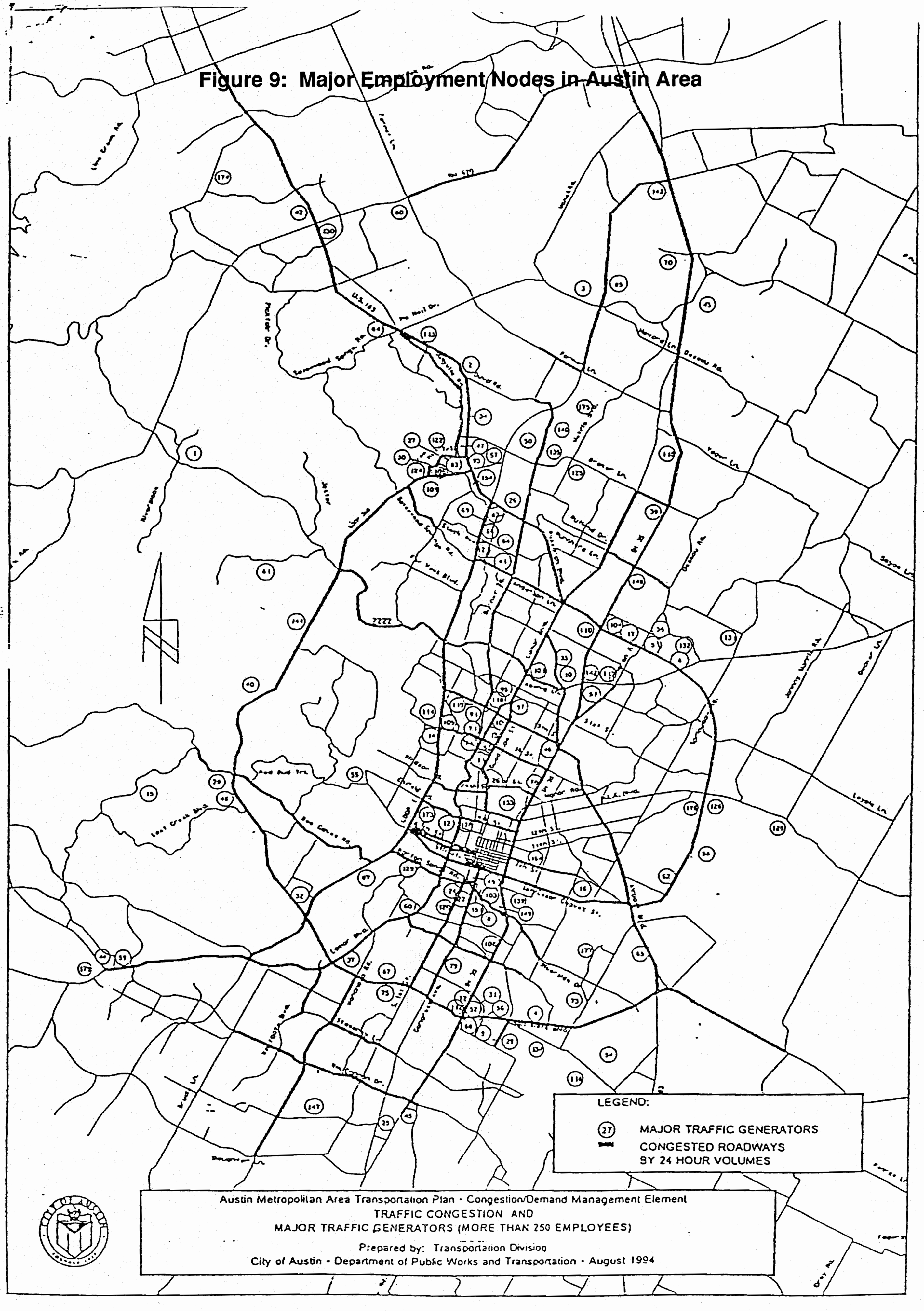
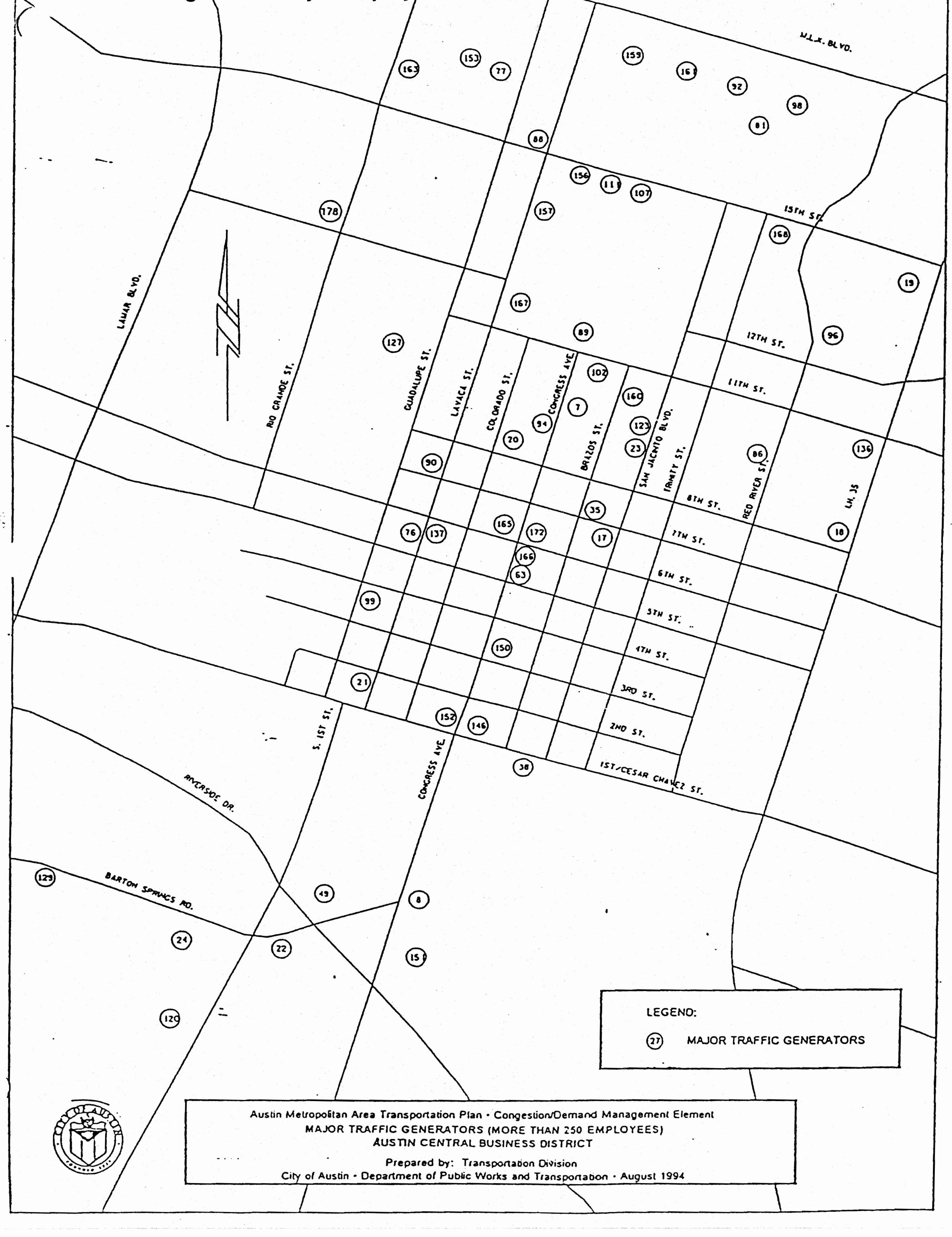


Figure 10: Major Employment Nodes in Downtown Austin



SATELLITE CITIES IDENTIFIED AS EMPLOYEE RESIDENTIAL LOCATIONS

Public Employers

The following public organizations have made available data collected from travel surveys: Texas Natural Resources Conservation Commission (TNRCC); City of Austin, Public Works and Transportation Department (PWTD); and City of Austin, Environmental and Conservation Services Department (ECSD). These public organizations are participants of the ATS sponsored V-Trip program and have conducted surveys to get information on commuting behavior. The City of Austin, PWTD has surveyed all employers at One Texas Center (OTC) and City of Austin, ECSD has surveyed all employers at Two Commodore Plaza (TCP). Tables 9, 10, and 11 show the total employees commuting from various zip codes in the Austin area for the three V-Trip participants. Because it takes 10 passengers to start a vanpool, zip codes with at least 10 employees are listed.

Table 9: Employee residential distribution for TNRCC

Zip Code	Number of Employees	Zip Code	Number of Employees
78759	71	78729	41
78758	111	78728	38
78757	52	78727	55
78756	15	78723	33
78753	94	78722	16
78752	15	78717	12
78751	20	78705	12
78750	30	78704	52
78749	29	78703	32
78748	27	78681	49
78746	27	78666	11
78745	44	78664	35
78744	12	78660	49
78741	15	78641	15
78737	11	78628	14
78736	10	78621	23
78734	10	78613	20
78731	40	78610	10

Source: TNRCC survey

Table 10: Employee residential distribution for OTC

Zip Code	Number of Employees
78753	12
78745	23
78704	18

Source: COA- PWTD survey

Table 11: Employee residential distribution for TCP

Zip Code	Number of Employees
78704	24
78741	14
78745	25

source: TCP survey

It can be seen that there are significant concentrations of employees residing in satellite cities for several major employers. For the TNRCC, several satellite cities have more than 10 employees residing in them. Table 12 lists the major satellite cities for the TNRCC.

Table 12: Major Satellite Cities for TNRCC

Satellite City	Zip Codes	Number of Employees
Buda	78610	10
Cedar Park	78613	20
Pflugerville	78660	49
Rollingwood/Westlake Hills	78746	27
Round Rock	78681&78664	84
San Leanna	78748	27

Table 12 indicates that there are ample employees residing in satellite cities to sustain a commuter vanpool system.

OTC and TCP, however, do not have the concentrations of employees in satellite cities that the TNRCC has, as indicated by Tables 10 and 11. Only three zip codes have more than 10 employees and none are satellite cities.

It should be noted that, although very few employees reside in the same areas for OTC and TCP, vanpool systems are still a viable commute option. The benefits of vanpooling still apply and Capital Metro has the capability of matching riders. However, vanpooling employees of OTC and TCP may more than likely ride with employees of other worksites due to the low concentrations of employees in satellite cities for one single worksite.

A source of error in the employee residential distributions arises from the fact that the data is collected from a survey. The surveys often are not returned by all employees. This means that there are a number of employees that are not accounted for which may be residing near other employees.

Private Employers

The identified private organizations have not conducted similar surveys. However, the employee residential distributions can be approximated using CTPP data. The following matrix, Table 13, shows the number of work trips from the satellite cities to the employment site zones. This reveals the satellite cities with the largest concentrations of employee residences for each employer.

Table 13: Work trip matrix

Origins	Destinations-Employers										
	Org1	Org2	Org3	Org4	Org5	Org6	Org7	Org8	Org9	Org10	Org11	Org12
Satellite Cities	zone 201	zone 214	zone 398	zone 62	zone 484	zone 183	zone 378	zone 167	zone 493	zone 498	zone 538	zone 214
Buda	9	4	3	2	0	0	4	0	8	0	0	4
Cedar Park	190	64	98	0	0	167	51	98	20	0	0	64
Leander	142	38	96	0	0	190	33	41	0	0	0	38
Manor	3	0	12	0	0	0	0	1	0	0	0	0
Pflugerville	150	46	111	13	0	42	51	76	0	5	8	46
Rollingwood	8	0	10	3	0	10	4	10	0	0	0	0
Round Rock	979	88	511	24	14	330	109	276	5	14	0	88
San Leanna	6	3	7	2	0	0	0	0	0	5	0	3
Westlake Hills	0	14	15	0	0	7	12	0	0	0	0	14

Source: Compiled by author

Table 13 indicates that there could possibly be large concentrations of employees that work for major private employers residing in satellite cities. Although the matrix shows work trips from origin zone to destination zone and not actual employee residences, a large number of work trips from an origin zone would very likely indicate that a large number of employees reside in that zone for an employer. Cedar Park, Leander, Pflugerville, and Round Rock appear to be the satellite cities producing the most work trips to the major private employers.

TARGETED EMPLOYERS

In order for an employer to be a likely candidate for the implementation of a commuter vanpool system, the employer must have concentrations of employees residing in satellite cities and either on-site amenities or a location within walking distance of mid-day destinations. Table 14 compares the on-site amenities available at three private worksites from above.

Table 14: On-Site Amenities of Three Private Worksites

Private Organization	Downtown Location?	Cafeteria	ATM	Child Care	Stamps	Dry Cleaning	Fitness	Direct Deposit
Organization3	No	Yes	Yes	No	Yes	No	No	Yes
Organization6	No	Yes	Yes	No	Yes	No	Yes	Yes
Organization7	Yes	No	Yes	No	No	No	Yes	Yes

Organization 3 has significant numbers of employees residing in satellite cities as shown in Table 13. In addition, the on-site amenities offered make up for the fact that Organization 3 is located in a low density suburban-like area. The presence of a cafeteria, ATM, and stamps as well as direct deposit allows employees to be less dependent on the automobile by making mid-day trips less necessary.

The same applies for Organization 6 which is also located in a low density area. Organization 6 has clusters of employees residing in satellite cities as well as many on-site amenities.

Organization 7 has groups of employees residing in satellite cities, but has very few on-site amenities. This, however, is compensated by Organization 7's downtown location. Many services and mid-day destinations are reachable on foot, therefore taking the place of on-site amenities.

There are numerous organizations, both public and private, that would make good candidates for the implementation of a commuter vanpool service. It should be kept in mind, however, that many other factors may play a role in a vanpool system's viability. Private organizations have the advantage of being able to benefit from the Energy Policy Act's rideshare/transit pass subsidy. However, without legislation requiring large employers to reduce commute trips, only public organizations in Austin have expressed interest in finding viable alternative commute modes.

GIS ANALYSIS

Because the necessary resources were not available at the time of this study, the complete methodology of developing routes and schedules outlined in the Methodology section was not performed. Specifically, network coverage databases were not available, thus making the routing aspect impossible. However, an alternative methodology was performed to demonstrate ride matching using a GIS software package. The software used was ARCVIEW. The following steps were taken:

1) Travel survey data obtained

Data from travel surveys were obtained from a few worksites in Austin. Survey results in EXCEL format were received from the TNRCC, OTC, and TCP. Selective data were then compiled into one database. Table 15 lists the fields of data in the database.

Table 15: Fields in Database

Field	Description
Number	Generic identification number
Organization/Worksite	The destination of the commuter
Zip	The five digit zip code
Scheduled Start Times	Time the commuter is scheduled to begin work
Reported Travel Time to Work	Travel time in minutes
Total One-Way Travel Distance to Work	Distance in miles
Mode Used	Code representing mode of travel

The scheduled start time is either the single reported start time or the most common start time if the survey obtained start times for every day of the week.

The reported travel time to work is the one-way travel time that a survey respondent cited. This, of course, may not be the actual travel time that the commuter took since the survey question is subject to inaccuracies.

The total one-way travel distance to work is the reported travel distance and is also subject to inaccuracies.

The mode used is either the single reported mode or the one used most often if the survey obtained modes used for every day of the week. Table 16 lists the modes of travel and the respective code.

Table 16: Codes for Modes of Travel

Code	Mode of Travel
1	Drove/rode in a vehicle for the disabled
2	Drove/rode alone in car, motorcycle, taxi
3	Rode in carpool with 2 employees
4	Rode in carpool with 3 employees
5	Rode in carpool with 4 employees
6	Rode in carpool with 5 employees
7	Rode in carpool with 6 employees
8	Rode in vanpool with 7 or more employees
9	Walked
10	Bicycled
14	Rode bus
99	Don't know/Refuse

The database was eventually converted from an EXCEL format to a dBase format so that it could be imported into ARCVIEW.

2) Digitized zip code map obtained

A zip code map with its table of attributes was obtained.

Each zip code area on the map is linked to the attribute table. The attribute table contains various pieces of information. Figure 11 illustrates how zip code areas on the map and table entries are related.

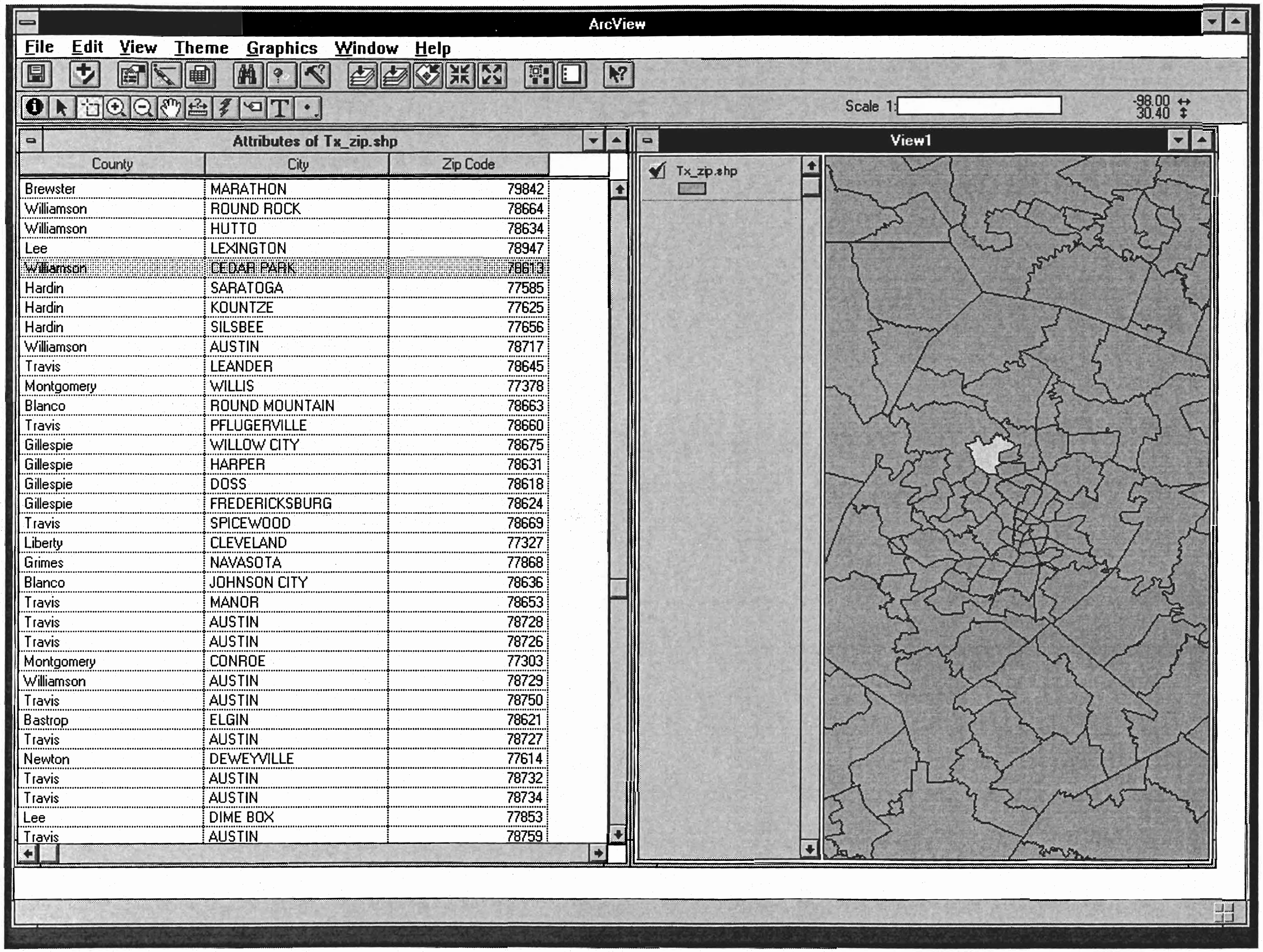
An individual can use the mouse to click on either a zip code area or a table entry. If a zip code area on the map is clicked it becomes highlighted as well as the respective table entry. The same works in reverse. Highlighting a table entry causes the respective zip code area on the map to be highlighted.

3) Employee database and zip code map are linked together

A link between the zip code attributes table and the employee database table is created to relate employees of a certain zip code to the zip code map. This is what is known as a "one to many" relationship. There are many employees residing in a zip code area. Using the zip code as the link, employees of one zip code are related to one record of the zip code attribute table.

Figure 12 illustrates the relationship between the zip code map, zip code attributes table, and employee database table after the link is performed.

An individual can click and highlight a zip code area on the map and not only does the respective zip code table entry become highlighted but also the respective employee database entries with the same zip code.



County	City	Zip Code
Brewster	MARATHON	79842
Williamson	ROUND ROCK	78664
Williamson	HUTTO	78634
Lee	LEXINGTON	78947
Williamson	CEDAR PARK	78613
Hardin	SARATOGA	77585
Hardin	KOUNTZE	77625
Hardin	SILSBEE	77656
Williamson	AUSTIN	78717
Travis	LEANDER	78645
Montgomery	WILLIS	77378
Blanco	ROUND MOUNTAIN	78663
Travis	PFLUGERVILLE	78660
Gillespie	WILLOW CITY	78675
Gillespie	HARPER	78631
Gillespie	DOSS	78618
Gillespie	FREDERICKSBURG	78624
Travis	SPICEWOOD	78669
Liberty	CLEVELAND	77327
Grimes	NAVASOTA	77868
Blanco	JOHNSON CITY	78636
Travis	MANOR	78653
Travis	AUSTIN	78728
Travis	AUSTIN	78726
Montgomery	CONROE	77303
Williamson	AUSTIN	78729
Travis	AUSTIN	78750
Bastrop	ELGIN	78621
Travis	AUSTIN	78727
Newton	DEWEYVILLE	77614
Travis	AUSTIN	78732
Travis	AUSTIN	78734
Lee	DIME BOX	77853
Travis	AUSTIN	78759

Figure 11: Relation between zip code map and attributes table records

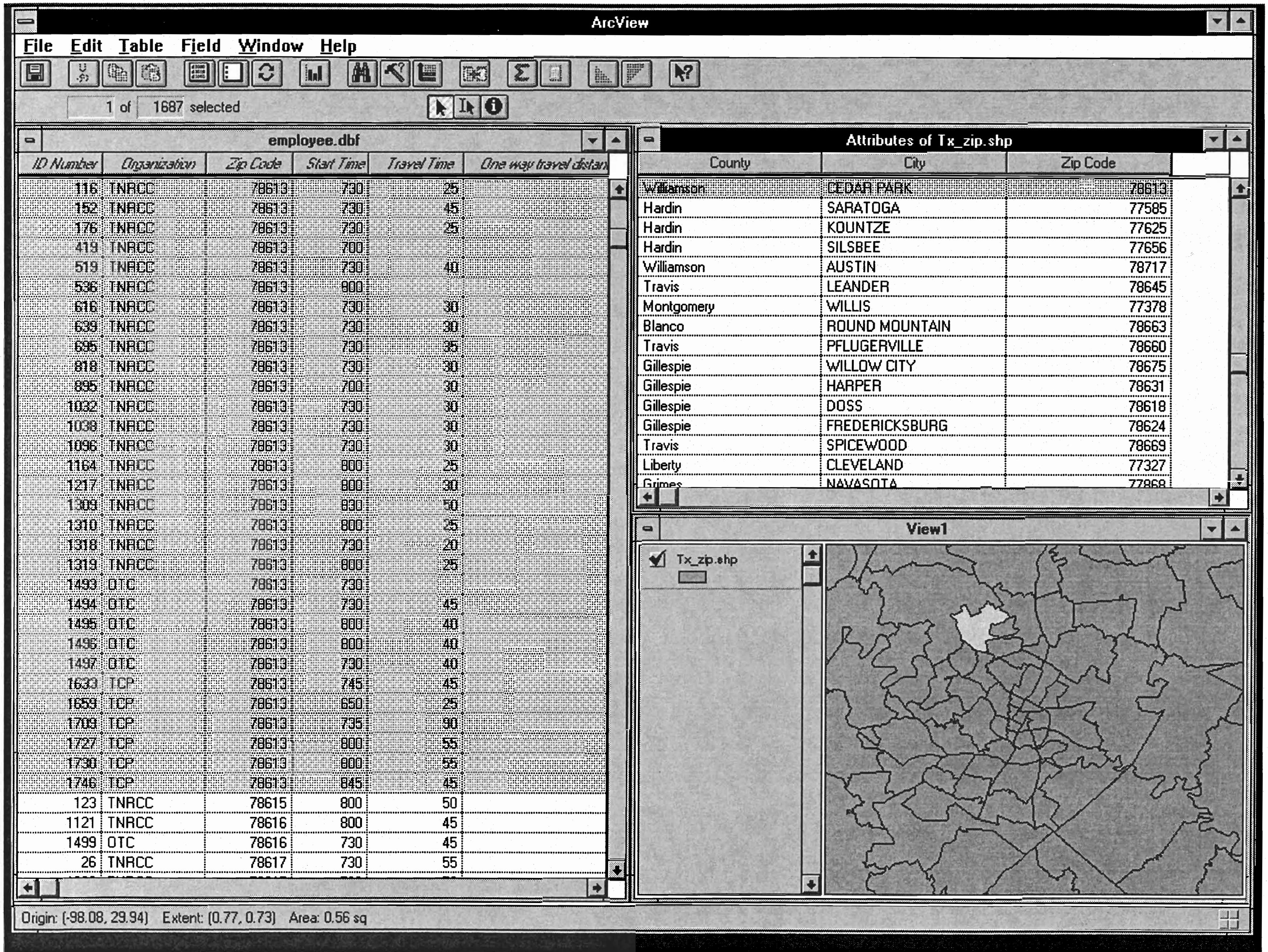


Figure 12: Relationship between zip code map, attributes table, and employee database

4) Query analysis performed to match riders

The Query Builder tool in ARCVIEW is a powerful tool for selecting features on a map and records in a table based on their attributes. The following example illustrates this kind of analysis:

Suppose that the goal is to match vanpool riders of a satellite city living in the same zip code. Clicking on the zip code area on the map with the mouse highlights all the employees residing in that zip code as Figure 12 illustrates.

The next step is to build a query. A vanpool party originating from zip code 78613, which is the satellite city Cedar Park, can consist of those employees that work at the same worksite, are scheduled to begin work at about the same time, and currently drive alone.

The Query Builder tool can perform this analysis. Figure 13 shows the Query Builder window. The query can be performed by specifying "Organization" = "TNRCC" and "start time" <= 830 and "mode used" = 2 and then choosing "select from set," which builds the query for the already selected set of employees. This selection singles out those who work at the TNRCC, are scheduled to begin work before 8:30 am, and currently drive alone.

Workers are selected from one worksite because a vanpool system is more efficient if it only reaches one destination rather than many destinations. Workers who begin their days before 8:30 am are singled out so vanpool schedules can match individual employee work schedules as best as possible. Workers who currently drive alone are chosen to maximize the environmental benefit of the vanpool system. Reducing the number of SOVs and VMT is one of the main objectives of a commuter vanpool system.

Figure 13 and 14 show the results of the query. Figure 14 is a closer examination of the resulting set of selected employees. As one can see, there are a significant number of employees that can be matched as vanpool riders who reside in Cedar Park and work at the TNRCC.

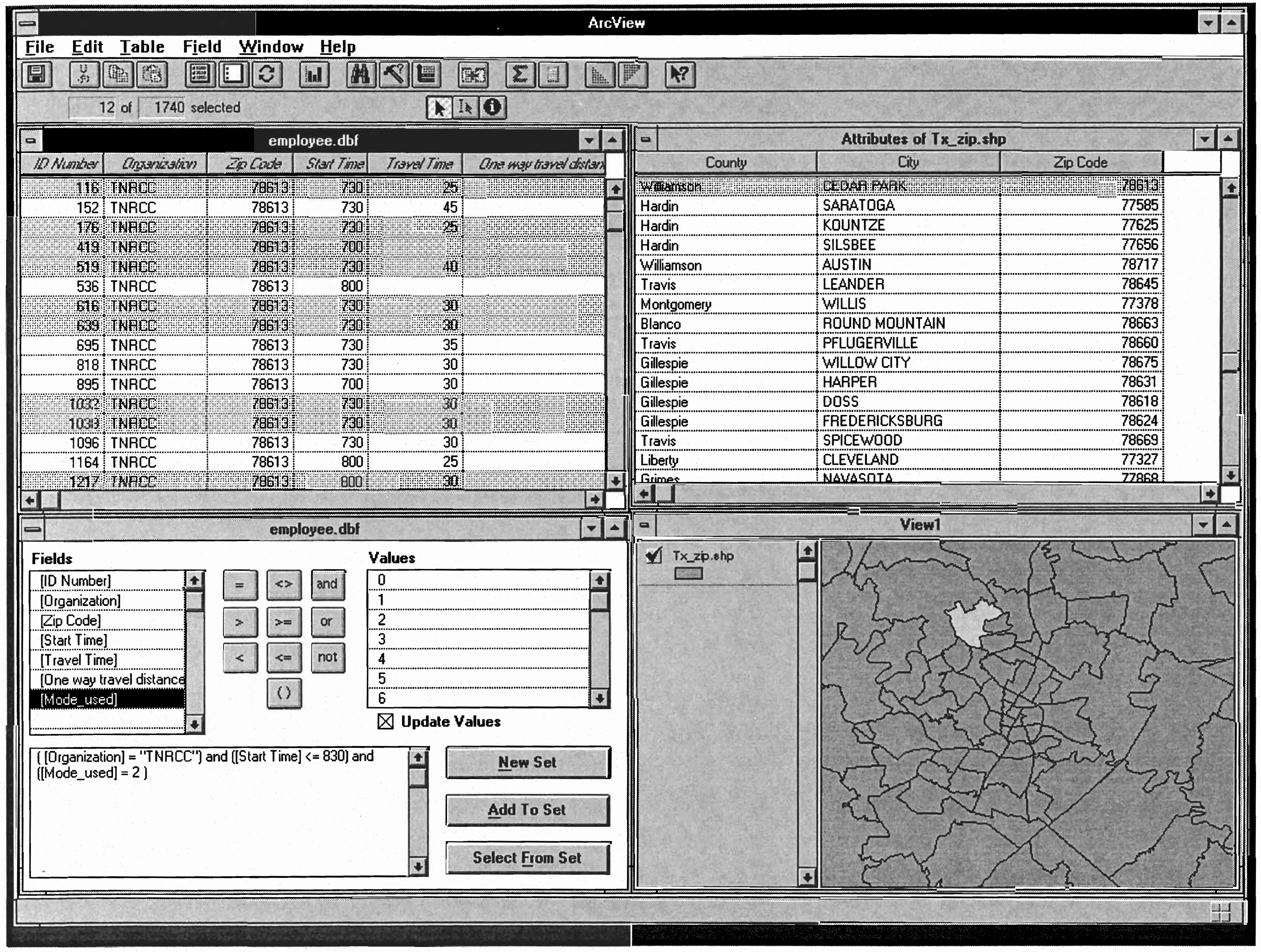


Figure 13: Building a Query in ARCVIEW

ArcView

File Edit Table Field Window Help

12 of 1740 selected

employee.dbf

ID Number	Organization	Zip Code	Start Time	Travel Time	One way travel distance	Mode_used
116	TNRCC	78613	730	25	13	2
152	TNRCC	78613	730	45	20	8
176	TNRCC	78613	730	25	17	2
419	TNRCC	78613	700			2
519	TNRCC	78613	730	40	30	2
536	TNRCC	78613	800			12
616	TNRCC	78613	730	30	16	2
639	TNRCC	78613	730	30	13	2
695	TNRCC	78613	730	35	17	3
818	TNRCC	78613	730	30		3
895	TNRCC	78613	700	30	15	8
1032	TNRCC	78613	730	30	10	2
1038	TNRCC	78613	730	30	17	2
1096	TNRCC	78613	730	30	20	8
1164	TNRCC	78613	800	25	13	3
1217	TNRCC	78613	800	30	17	2
1309	TNRCC	78613	830	50		2
1310	TNRCC	78613	800	25	24	2
1318	TNRCC	78613	730	20	16	2
1319	TNRCC	78613	800	25	11	3
1493	OTC	78613	730		20	2
1494	OTC	78613	730	45	20	2
1495	OTC	78613	800	40	17	2
1496	OTC	78613	800	40	20	2
1497	OTC	78613	730	40	22	2
1633	TCP	78613	745	45	23	2
1659	TCP	78613	650	25	23	2
1709	TCP	78613	735	90	28	14
1727	TCP	78613	800	55	28	14
1730	TCP	78613	800	55	23	2
1746	TCP	78613	845	45	28	2
123	TNRCC	78615	800	50	37	2
1121	TNRCC	78616	800	45	28	2
1499	OTC	78616	730	45	40	3
26	TNRCC	78617	730	55	26	2
1000	TNRCC	78617	700	50	30	2

Figure 14: Query Results

CONCLUSIONS

VIABILITY OF THE COMMUTER VANPOOL SYSTEM

The viability of the commuter vanpool system described depends on employer involvement. As long as Austin remains unaffected by ECO regulations, major employers will have little incentive to reduce their commute trips. Therefore, the sector in Austin with the greatest potential for implementation is the public sector. Specifically, the public organizations involved with the ATS sponsored V-Trip program have the greatest potential because these employers have demonstrated their commitment to providing their employees with alternatives to the SOV. This means that they are more likely to provide the support services and on-site amenities needed to make vanpooling successful.

EFFECTIVENESS OF PROPOSED FRAMEWORK FOR DEVELOPING SYSTEM

The effectiveness of the proposed framework remains untested. This is due to two reasons. First, this study was performed without full access to the necessary information. For instance, the research could have been facilitated if the private employers were able to provide employee residential locations and employee commute information. Because this information is sensitive, private employers are hesitant to make it available.

Second, the time limitations of this project did not allow for certain tasks to be performed. For instance, the stated preference survey, which was designed to determine demand for the commuter vanpool system, was not used by the time this report was finished. The task of designing the survey, distributing it, and collecting it was too cumbersome to be performed.

Another task that was not completed was the development of vehicle routes. This required that a digitized road network of Austin be obtained and calibrated to simulate real life traffic conditions. Obviously, this task requires considerable time and effort beyond the scope of this project and was therefore not performed.

BENEFITS REALIZED BY A DIVERSE GROUP OF PARTICIPANTS

The three participants involved in the conceptualized commuter vanpool system are the transit provider, the employer, and the employees. In theory, each participant should find the commuter vanpool system attractive. The transit provider would find the system to be consistent with their current services and therefore no more of a burden to operate. The employer would find the system attractive because of the many benefits and minimal effort required to provide the system. In the case of the private sector, the transit/rideshare pass benefit would require employers to take the initiative to obtain the benefit. The employees would find the service attractive because of its competitiveness with the automobile as well as the tangible and intangible benefits.

Although each party may find the commuter vanpool system to be attractive, the system may not be implemented due to institutional reasons. Cooperation between agencies involved in providing the system, the employers, and the employees is necessary for the system to be successful. This is especially true in the initial stages of implementation. Interest among each party must be maintained in order to overcome this barrier.

RECOMMENDED IMPROVEMENTS TO THE ANALYTICAL TOOLS USED

The analytical and computational tools highlighted in this report could be improved to make the procedures more efficient.

First, it was found that compiling a geographic database with survey data from three different organizations was problematic. Each survey obtained different information and was coded differently; thus, causing problems when compiling the data into one database. This problem was overcome by transferring data by hand. However, if the database were extremely large, considerable time would have to be taken to create the geographic database.

Second, expanding the database to include more information would assist in properly matching vanpool riders. More accurate information on residential locations and schedule information would allow for better ride matching. Additional information like days worked, afternoon leave times, lunch hours, etc. could easily be obtained through the same kind of survey.

Third, geographic information systems have the capability of performing vehicle routing and demand modeling simultaneously. An innovative approach to performing analysis on the commuter vanpool system would be to use the stated preference survey results to model vanpool demand with the GIS software. At the same time, vehicle routing could be performed with the same software if the digitized transportation network were available. These two tasks can be integrated to efficiently plan vanpool/transit systems.

Fourth, as a long range concept, the Internet or World Wide Web could be used to make commuter vanpool systems more efficient. Data collection could be facilitated with on-line surveys, which is being done in some cities currently. Information such as vehicle routes and schedules could be displayed, thereby allowing commuters to better plan their work trips.

REFERENCES

Aronoff, Stan. Geographic Information Systems: A Management Perspective. Ottowa, Canada: WDL Publications 1993.

Aulick, Michael R. [Memorandum to Austin Transportation Study, Policy Advisory Committee] Voluntary Vehicle Trip Reduction Program (V-TRIP) as Part of the 1994 Clean Air Metro Austin Program. 8 March 1993.

Austin Transportation Study. Austin Metropolitan Area Plan. 1994.

Beaton, Patrick, H. Meghdir, and J. Carragher. "A Stated Choice Performance Evaluation of Selected Transportation Control Measures and their Transfer Across Sites." Transportation Research Board, 74th Annual Meeting, Washington, D.C. 22-28 Jan 1995.

California Energy Commission. "Clean and Alternative Fuels and Vehicles in California. "19 (June. 1992)

California Energy Commission. "Natural Gas Vehicle Fact Sheet." 19 (June. 1992)

Capital Metro. Vanpool Drivers Guide

Cervero, Robert. Suburban Gridlock. New Brunswick, New Jersey, 1986.

Clean Air Act Law and Explanation. Chicago: Commerce Clearing House, Inc., 1990

Davidson, Diane." The Role of Site Amenities as Transportation Demand Management Measures." Transportation Research Board, 74th Annual Meeting, Washington, D.C. 22-28 Jan 1995.

Environmental Systems Research Institute, Inc. PC Network User's Guide 1992

Environmental Systems Research Institute, Inc. Introducing ArcView 1994

Federal Highway Administration. ISTEA Selected Fact Sheets. Washington, D.C., 1993.

Greater Austin Chamber of Commerce Directory of Austin-Area Major Employers. 1994

Lerner, Abraham, and Sandra Rosenbloom. Non Traditional Transit Service Study: The 183 Corridor, Austin, Texas. Center for Transportation Research: U of Texas at Austin 1988.

Ortuzar, J de D. and L.G. Willumsen Modelling Transport. Second Edition. West Sussex, England: Wiley 1990.

Pisarski, Alan. Commuting in America: A National Report on Commuting Trends and Patterns. Westport, Conn: The Eno Foundation for Transportation, 1987.

Rosenbloom, Dr. Sandra Developing a Comprehensive Service Strategy to Meet a Range of Suburban Travel Needs. U.S. Department of Transportation. May 1990.

Rosenbloom, Dr. Sandra. Para-Transit in Suburbia: The Experiences of 20 Mid-Sized American Cities. Working Paper 015, The Graduate Program in Community and Regional Planning, University of Texas at Austin 1990.

Transportation Research Board. Guidelines for using vanpools and Carpools as a TSM Technique. National Cooperative Highway Research Program Report 241 (December 1981).

University Transportation Research Center Region II. Employee Commute Options Guidebook New York: May 1994.

US Bureau of Census, State and Metropolitan Area Data Book 1991: Metropolitan Areas, Central Cities, States. A Statistical Abstract Supplement. 4th Edition, US Department of Commerce, NTIS Press, Springfield, Virginia, 1992.

US Bureau of Census. Statistical Abstract of the United States 1992. US Department of Commerce, NTIS Press, Springfield, Virginia, 1991.

US Bureau of Census. County and City Data Book, 1988 US Department of Commerce, NTIS Press, Springfield, Virginia 1992.

APPENDIX A

Table A1: Variables Pertinent to Mode Choice

Table A1:Variables

Variable	Type of Variable	Utility Equation	Relationship to Prob of Ridesharing	Description	Survey Quest/Section(s)
Travel time	Char. of system	both	+	Tc-Trs	2,III
Travel cost	Char. of system	both	+	Cc-Crs	3,5,6,III
Children	Char. of trip maker	car	-	1:have children age<5, 0:otherwise	14
Guaranteed ride home	Char. of system	rs	+	1: GRH exists, 0:otherwise	III
Preferential Parking	Char. of system	rs	+	1: P.P. exists, 0:otherwise	III
Vehicles/# drivers' licenses in H.H.	Char. of trip maker	car	-		15,16
Sex	Char. of trip maker	rs	+	1: Male, 0:Female	10
Income	Char. of trip maker	car	-	Combined household income	8
Walk time from parking to worksite	Char. of system	rs	+	in minutes	4
Age	Char. of trip maker	car	-		9
Flexibility in schedule	Char. of trip maker	rs	+	1:start time can vary by 1/2 hour or more, 0:otherwise	12
Large # of trip chains per week	Char. of trip maker	car	-		17
Need for midday business travel	Char. of trip maker	rs	-	in days per week	18
Environmental consciousness	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19b
Mid-day shuttle	Char. of system	rs	+	1:shuttle exists, 0:therwise	III
Save wear on car	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19a
Not having to drive	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19c
Increased reliability/safety of commute	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19d
Socializing opportunities with ridesharing acquaintances	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19e

Opportunity for riders to spend commuting time reading,sleeping,relaxing	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19f
Reduced anxiety about parking or need to find parking	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19g
Possible reduction in insurance rates on personal vehicles for vanpoolers	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19h
Employer encourages ridesharing to reduce need for parking	Char. of trip maker	rs	+	Benefit of rs with importance scale from 1 to 10	19i
ATM machine	Char. of worksite	rs	+	On-site service that reduces auto dependence	Obtained directly from worksite
Cafeteria	Char. of worksite	rs	+	On-site service that reduces auto dependence	Obtained directly from worksite
Child Care	Char. of worksite	rs	+	On-site service that reduces auto dependence	Obtained directly from worksite
Stamps	Char. of worksite	rs	+	On-site service that reduces auto dependence	Obtained directly from worksite
Dry Cleaning	Char. of worksite	rs	+	On-site service that reduces auto dependence	Obtained directly from worksite
Fitness	Char. of worksite	rs	+	On-site service that reduces auto dependence	Obtained directly from worksite
Direct Deposit	Char. of worksite	rs	+	On-site service that reduces auto dependence	Obtained directly from worksite

APPENDIX B

Figure B1: Stated Preference Survey

I. Travel Characteristics

1. How did you get to work today?

a.	Drove alone	d.	Carpooled with acquaintance
b.	Rode the bus	e.	Vanpooled
c.	Carpooled with family member	f.	Other ___________

2. What was your travel time to work this morning? _______________(in minutes)

3. How far did you travel to get to work today? ________________(in miles)

4. How much time did it take for you to get from your parking spot to the work site today? ________________(in minutes)

5. What was your parking cost today (if any)?______________(in dollars)

6. How much was your bus fare today (if any)?________________(in dollars)

II. Socio-Economic Characteristics

7. What branch of Travis County do you work for? ___________________________

8. What is the closest major intersection to your residence?: ______________________ and________________________

9. What is your home zip code ___________

10. [Optional Question] What is the gross annual income of your household?

a.	under $15,000	d.	$45,000 - $60,000	g.	$90,000 - $105,000
b.	$15,000 - $30,000	e.	$60,000 - $75,000	h.	$105,000 -$120,000
c.	$30,000 - $45,000	f.	$75,000 - $90,000	i.	over $120,000

11. What is your age?

a.	under 16	d.	25 to 29	g.	40 to 44	j.	55 to 59
b.	16 to 19	e.	30 to 34	h.	45 to 49	k.	60 to 64
c.	20 to 24	f.	35 to 39	i.	50 to 54	l.	65 and over

12. What is your gender? Male Female

13. What are your normal work hours? ___:___ (AM or PM?) to ___:___ (AM or PM?)
Start time Leave time

14. Which describes your schedule?
   a. my daily hours cannot vary at all
   b. my daily hours can vary up to 15 minutes
   c. my daily hours can vary up to 30 minutes
   d. my daily hours can vary up to 45 minutes
   e. my daily hours can vary up to 1 hour
   f. my daily hours can vary more than 1 hour up to _____hours and _____minutes

15. What days do you commute?
   a. Monday through Friday, or
   b. Check all days that apply:
   Sun (U) Mon (M) Tue (T) Wed (W) Thu (R) Fri (F) Sat (S)

16. Do you have any children in day care? Yes No

17. How many motor vehicles (motorcycles, cars, trucks) does your household have?____________

18. How many individuals in your household are licensed to drive?____________

19. While going to or from work, how many days per week do you make trips for personal purposes (for shopping, bank, dry cleaners, etc)?

a. None c. 2 days a week e. 4 days a week g. 6 days a week
b. 1 day a week d. 3 days a week f. 5 days a week h. 7 days a week

20. How often do you travel for work related purposes during the day?

a. Never c. 2 days a week e. 4 days a week g. 6 days a week
b. 1 day a week d. 3 days a week f. 5 days a week h. 7 days a week

21. Which are important reasons for ridesharing (carpooling or vanpooling)? Use a scale of 1 to 10 (10=very important, 1=not important) to **rate** each reason.

a. ____Save wear on personal vehicle
b. ____Environmentally friendly form of transportation
c. ____Less of a need to drive
d. ____Increased reliability/safety of commute (in the case of vanpooling)
e. ____Socializing opportunities with ridesharing acquaintances
f. ____Opportunity to spend commuting time reading, sleeping, or relaxing
g. ____Reduced need to find parking or anxiety about parking
h. ____Some insurers will lower rates on personal vehicles for vanpool riders
i. ____Employer encourages ridesharing to reduce need for parking
j. ____Monetary savings

III. Choice Experiment

The following is a choice experiment for those who do not currently vanpool or carpool with acquaintances. You will be asked to choose between two commuting modes: either to continue your current mode of travel or to rideshare (carpool or vanpool). Ridesharing is where you would carpool or vanpool either by getting picked up at your residence or by driving to a pickup point. Ridesharing groups are matched for free either by Capital Metro or by your employer. Each scenario has a different set of attributes. The following list of definitions explains each attribute in case there is any confusion. Check off the mode that you would realistically choose for each hypothetical situation.

Mid-day shuttle: a service during the lunch hour that transports ridesharers to eating establishments, shopping, and other mid-day destinations.

Rideshare cost per day: the expense that a ridesharer pays to get to work every day. It includes all fares and gas expenses.

Rideshare added traveltime: the additional one way travel time to get to the worksite caused by the need to wait for rides and travel time to pick up other riders.

Guaranteed ride home: a service for ridesharers where a taxi will be provided in case of emergencies causing the need for the employee to leave work.

Preferential parking: where the closest parking spaces to the worksite are designated as carpool/vanpool spots.

Section III-A	Midday Shuttle	Rideshare cost per day	Rideshare added one-way travel time (min)	Guaranteed Ride Home	Preferential Parking	I choose to use my current mode	I choose to rideshare
Example							
1	Yes	$0.50	5	Yes	No		X
2	No	$4.00	5	No	Yes	X	
Scenario							
1	No	$1.50	15	No	Yes		
2	No	$1.50	5	No	Yes		
3	Yes	$0.50	15	Yes	Yes		
4	Yes	$4.00	5	Yes	Yes		
5	No	$4.00	30	Yes	No		
6	Yes	$0.50	30	No	Yes		
7	Yes	$4.00	30	Yes	No		
8	No	$1.50	30	No	Yes		
9	Yes	$1.50	15	No	No		
10	Yes	$1.50	5	No	No		
11	Yes	$4.00	5	No	No		
12	No	$4.00	5	No	No		
13	No	$0.50	30	No	No		
14	Yes	$1.50	5	No	Yes		
15	No	$0.50	15	No	No		
16	No	$0.50	30	No	Yes		
17	Yes	$4.00	30	Yes	Yes		
18	Yes	$4.00	15	No	Yes		

Table B1: 72 Stated Preference Scenarios

Stated Choice Preference Survey Design					
Variables	Midday Shuttle	Rideshare cost	Rideshare added travel time	Guaranteed Ride Home	Preferential Parking
Outcome1	Yes	High	Faster	Yes	Yes
Outcome2	No	Med	In-Between	No	No
Outcome3		Low	Slower		
Options					
1	Yes	High	Faster	Yes	Yes
2	Yes	High	Faster	Yes	No
3	Yes	High	Faster	No	Yes
4	Yes	High	Faster	No	No
5	Yes	High	In-Between	Yes	Yes
6	Yes	High	In-Between	Yes	No
7	Yes	High	In-Between	No	Yes
8	Yes	High	In-Between	No	No
9	Yes	High	Slower	Yes	Yes
10	Yes	High	Slower	Yes	No
11	Yes	High	Slower	No	Yes
12	Yes	High	Slower	No	No
13	Yes	Med	Faster	Yes	Yes
14	Yes	Med	Faster	Yes	No
15	Yes	Med	Faster	No	Yes
16	Yes	Med	Faster	No	Yes
17	Yes	Med	In-Between	Yes	No
18	Yes	Med	In-Between	Yes	Yes
19	Yes	Med	In-Between	No	No
20	Yes	Med	In-Between	No	Yes
21	Yes	Med	Slower	Yes	No
22	Yes	Med	Slower	Yes	Yes
23	Yes	Med	Slower	No	No
24	Yes	Med	Slower	No	Yes
25	Yes	Low	Faster	Yes	No
26	Yes	Low	Faster	Yes	Yes
27	Yes	Low	Faster	No	No
28	Yes	Low	Faster	No	Yes
29	Yes	Low	In-Between	Yes	No
30	Yes	Low	In-Between	Yes	Yes
31	Yes	Low	In-Between	No	Yes
32	Yes	Low	In-Between	No	No
33	Yes	Low	Slower	Yes	Yes
34	Yes	Low	Slower	Yes	No
35	Yes	Low	Slower	No	Yes
36	Yes	Low	Slower	No	No
37	No	High	Faster	Yes	Yes
38	No	High	Faster	Yes	No
39	No	High	Faster	No	Yes
40	No	High	Faster	No	No
41	No	High	In-Between	Yes	Yes
42	No	High	In-Between	Yes	No
43	No	High	In-Between	No	Yes
44	No	High	In-Between	No	No
45	No	High	Slower	Yes	Yes
46	No	High	Slower	Yes	Yes
47	No	High	Slower	No	No

48	No	High	Slower	No	Yes
49	No	Med	Faster	Yes	No
50	No	Med	Faster	Yes	Yes
51	No	Med	Faster	No	No
52	No	Med	Faster	No	Yes
53	No	Med	In-Between	Yes	No
54	No	Med	In-Between	Yes	Yes
55	No	Med	In-Between	No	No
56	No	Med	In-Between	No	Yes
57	No	Med	Slower	Yes	No
58	No	Med	Slower	Yes	Yes
59	No	Med	Slower	No	No
60	No	Med	Slower	No	Yes
61	No	Low	Faster	Yes	Yes
62	No	Low	Faster	Yes	No
63	No	Low	Faster	No	Yes
64	No	Low	Faster	No	No
65	No	Low	In-Between	Yes	Yes
66	No	Low	In-Between	Yes	No
67	No	Low	In-Between	No	Yes
68	No	Low	In-Between	No	No
69	No	Low	Slower	Yes	Yes
70	No	Low	Slower	Yes	No
71	No	Low	Slower	No	Yes
72	No	Low	Slower	No	No