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16. Abstract

This report presents a preliminary study of changes over time in internal person trips per person and internal auto-driver trips per person for urban areas within Texas. Trip generation rates apparently have been increasing as a result of a greater propensity to travel and changes in socioeconomic characteristics. The rate of increase varies among the individual urban areas, being dependent on certain characteristics of the urban area.

The historical rates of increase in internal person trips and auto-driver trips per person are identified using macroscopic measures. Although the rate of increase in trip generation rates is expected to decrease in future years, total trip generation is expected to increase unless the degree of mobility provided by urban street networks is significantly decreased and/or the upward trend in socioeconomic characteristics is arrested or reversed.

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A PRELIMINARY EVALUATION OF THE TEMPORAL STABILITY OF TRIP GENERATION RATES

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Research Report 167-6

Urban Travel Forecasting
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Texas Transportation Institute
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College Station, Texas

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A PRELIMINARY EVALUATION OF THE TEMPORAL STABILITY OF TRIP GENERATION RATES

Table of Contents

Abstract . . . . . *v*

Summary . . . . . *vi*

Implementation Statement . . . . . *viii*

Introduction 1

Analytical Approach 3

Historical Trends in Trip Generation 6

I. Analysis of General Statewide Travel Data 6

II. Statewide Trends, Screenline Count Analysis 8

III. Trends in Individual Urban Areas 9

IV. Discussion of Origin-Destination Data for Selected Urban Areas 16

Future Trends in Trip Generation 18

I. Analysis of Statewide Travel Data 18

II. Trends in Individual Urban Areas 20

Conclusions 23

Glossary of Terms 26

References 27

Appendices 29

Table of Contents. 30

LIST OF FIGURES

FIGURE 1: Relation Between Person and Auto-Driver Trips Per Person 4

FIGURE 2: Trends in Person Trips Per Person Over Time, Texas Study Areas 10

FIGURE 3: Effect of Geographical Location On Per Capita Trip Generation Rates, Urban Areas With Population Less Than 175,000 11

FIGURE 4: Effect of Median Income On Per Capita Trip Generation Rates, Urban Areas With Population Less Than 175,000 . 12

FIGURE 5: Trends in Trip Generation Rates Over Time For Different Income Levels, Urban Areas With Population Less Than 175,000 13

FIGURE 6: Effect of Geographical Location On Per Capita Trip Generation Rates, Urban Areas With Population Greater Than 175,000 14

FIGURE 7: Effect of Median Income On Per Capita Trip Generation Rates, Urban Areas With Population Greater Than 175,000 15

FIGURE 8: Trends in Per Capita Median Income and Trip Generation Rates, Selected Urban Study Areas 17

FIGURE 9: Historical and Forecasted Indicators of Urban Travel . 19

FIGURE 10: Projected Rates of Per Capita Trip Generation For "Typical" Large Urban Areas (Population Greater Than 175,000) 21

FIGURE 11: Projected Rates of Per Capita Trip Generation For "Typical" Large Urban Areas (Population Greater Than 175,000) 22

LIST OF TABLES

TABLE 1: Historical Trends in Per Capita Trip Generation, Texas Cities (1960-1970). 15

TABLE 2: Changes in Per Capita Trip Generation Rates Over Time For Selected Urban Areas. 16

TABLE 3: Changes In Median Per Capita Income Over Time For Selected Urban Areas. 17

TABLE 4: Annual Percent Of Increase, Statewide Travel Data 19

TABLE 5: Projected Annual Percent of Increase in Person Trips Per Person, Texas Cities 21

TABLE 6: Estimated Annual Percent of Increase in Person Trips Per Person, Texas Cities 24

TABLE 7: Comparison of Per Capita Generation Rates Forecasted In Selected Transportation Studies and Rates Forecasted Using Recommended Procedure 25

ABSTRACT

This report presents a preliminary study of changes over time in internal person trips per person and internal auto-driver trips per person for urban areas within Texas. Trip generation rates apparently have been increasing as a result of a greater propensity to travel and changes in socioeconomic characteristics. The rate of increase varies among the individual urban areas, being dependent on certain characteristics of the urban area.

The historical rates of increase in internal person trips and auto-driver trips per person are identified using macroscopic measures. Although the rate of increase in trip generation rates is expected to decrease in future years, total trip generation is expected to increase unless the degree of mobility provided by urban street networks is significantly decreased and/or the upward trend in socioeconomic characteristics is arrested or reversed.

Key Words: Trip Generation, Transportation Planning, Travel Forecasting, Urban Transportation Studies, Latent Travel Demand

SUMMARY

Existing travel forecasting procedures have generally underestimated the future traffic volumes which occur on street and highway facilities. Part of this underestimation is believed to be due to a failure to forecast changes in the travel desires of the various socioeconomic groups comprising the urban population. Evaluation of trip generation characteristics and their temporal stability is necessary if underestimation is to be avoided in the future.

Macroscopic analyses of both statewide travel indicators and individual urban area trip generation data were used in identifying historical and projecting future rates of change in trip generation. The analysis of individual urban areas involved a study of the different per capita rates of trip generation determined in the various Texas origin-destination surveys. The study of statewide travel data utilized more general indicators of urban travel trends such as urban vehicle miles of travel, urban population, etc.

Results of these analyses indicate that, in Texas, both internal person trips per person and internal auto-driver trips per person have been increasing historically and can be expected to continue to increase in the future. The rate of increase in trip generation is expected to decrease in the future as the percentage of eligible population with drivers licenses reaches 100. Vehicles per capita in urban areas within Texas are estimated to attain a saturation level by about 1980. After 1980, additional vehicle ownership will be related to population changes and should not affect per capita trip making. Further increases in person trips and auto-driver trips per person will result primarily from an increased propensity to travel.

Both the historical and projected rates of increase in per capita trip generation vary among the different urban areas. During the 1960's, rates of increase as low as 3% per year and as high as 8.3% per year were identified as being characteristic of different urban areas. Factors such as population, vehicles per capita, and median income seem to explain much of the variation in the trip making rates.

It also appears that two different traffic volumes should be considered in the transportation planning process. The first volume is that which could reasonably be expected to occur given the characteristics and capacity of a transportation system. The second would be the volume of trips which would occur if all travel desires were to be served. Apparently, all travel desires have not been served historically in certain urban areas, nor does it appear as if they will be served in the future. If increases in urban transportation facilities do not keep pace with the desired level of travel, latent demand will be generated.

IMPLEMENTATION STATEMENT

The urban transportation planning process consists of four basic elements — trip generation, trip distribution, modal split, and traffic assignment. The findings of this study are applicable to the trip generation aspect of this planning process.

This report documents the historical and future rates of increase in internal person trips per person and internal auto-driver trips per person for Texas study areas. Analyses indicate that per capita trip generation has increased significantly over time due to changes in socioeconomic characteristics and a greater propensity to travel.

As a result, if data obtained in previous origin-destination surveys together with limited primary collection of travel survey data are to be applied to future synthetic studies, it is necessary to implement techniques which can be used to account for the different time periods involved. The rates of increase presented in this report indicate that trip generation rates have been increasing significantly but at different rates in different urban areas. This suggests that future O-D suvey data collection should be designed to quantify the change in trip generation and travel characteristics. If the tendency for urban residents, within socioeconomic classes, to make an increasing number of trips is not considered in the forecasting process, the total number of future trips may be underestimated and a latent travel demand can be expected to develop.

INTRODUCTION

The Problem

Transportation facilities are generally planned to serve a travel demand estimated for some future design year. However, in many instances, the traffic volumes on newly opened freeway segments have greatly exceeded the volume which was anticipated; the result has been that a traffic volume projected for twenty years in the future is often a reality well in advance of that design year. The resulting urban traffic congestion has brought with it considerable criticism of the transportation planning process.

The low forecast volumes are, in large measure, due to underestimation of changes in the travel desires of the urban population. Evaluation of trip generation characteristics and the temporal stability of such relations is necessary if underestimation of traffic demand is to be minimized in the future.

Trip Generation Considerations

Trip generation rates provide a quantification of the volume of trips generated by various analysis units based upon the land use and/or socioeconomic characteristics of those units. Study year generation rates have historically been determined from the conventional home-interview origin-destination survey. These rates are often assumed to remain constant over time, the implicit assumption being that any increase in per capita travel will be the result of a change in socioeconomic characteristics. Such a procedure accounts for increases in trip generation due to upward mobility in socioeconomic status (e.g., an increase in the proportion of DU's in the higher socioeconomic categories with a corresponding decrease in the lower category) and increasing auto ownership resulting with increasing personal income. However, any tendency for DU's within a given socioeconomic category is generally not considered.

Definition of the components into which urban trip generation can conceptually be divided assists in identifying those areas which might contribute to an increased per capita travel demand over time. The following components also

provide a framework for both the reevaluation of trip generation analyses and the development of improved forecast procedures:

1. Growth Traffic is due to changes in the demographic characteristics of an urban area. Since most urban areas have been increasing in population, this traffic component has generally resulted in an increased number of trips. However, it is important to realize that some urban areas have exhibited modest or no potential for population increases. Under such conditions, the growth traffic component will be zero or negative.

   If an area is increasing in population, the added increment of population is assumed to exhibit the same trip generation characteristics as the base population. In the case of a decline in population, the residual population is assumed to exhibit the same trip characteristics as the original base population.

2. Socioeconomic Traffic is due to shifts in the socioeconomic levels within an urban area. Persons, or households, migrating from one socioeconomic group to another are assumed to have travel characteristics similar to the group with which they have become associated. In most urban areas, the tendency has been for upward socioeconomic migration. Consequently, this component has, historically, generally resulted in greater trip making.

3. Developed Traffic is a result of changes in land use within a travel corridor brought about by either a change in an existing transportation facility or by the development of a new facility. Any new, high type facility, such as a freeway, has historically brought about land use changes that create increased traffic in the corridor. Hence, developed traffic is dependent on the location of the new traffic generators associated with the new facility. The existence of developed traffic does not necessarily imply that urban growth traffic has occurred; it may simply be a relocation of traffic generators and their associated traffic.

4. Converted Traffic consists of trips that are being made by another mode, or modes, of transportation which are converted to a different mode after the opening of a new facility.

5. Diverted Traffic consists of trips that are presently being made by the same mode and are diverted to the new or improved facility.

6. Cultural Traffic results from a change in propensity to travel due to the changing life style of the population. Although it is often confused with growth traffic, cultural traffic results from changes in customs, cultural habits, personal preferences, and level of mobility which influence the number of trips made by household members.

7. Induced Traffic consists of new trips that are made because of the added convenience, or increased accessibility, offered by a new facility.

The conventional urban transportation planning process considers, to some extent, the first five components enumerated above in the sequential steps of trip generation, trip distribution, and traffic assignment. A Texas Transportation Institute Report (Research Report 167-5) presented an approach for considering the effect of induced traffic.

The present planning process does not consider the effect of cultural traffic as such, although some of this traffic is accounted for through the forecasting of increased auto ownership and use. The fact that persons in the same socioeconomic level apparently make more trips today than, say, ten years ago is not entirely accounted for by existing procedures. However, in evaluating data relative to urban travel growth, it is difficult to clearly separate the individual effects of socioeconomic and cultural traffic.

Analytical Approach

Analyses are developed to identify the rate of change in internal person trips per person over time for urban areas in Texas. Since internal person and internal auto-driver trips per person are correlated (Figure 1), the rate of increase identified for one of these generation rates can be directly applied to the other with an acceptable degree of accuracy. The rates of change identified by these analyses account for the effect of both an increased propensity to travel and changes in socioeconomic characteristics.

Two different analytical approaches, or levels of analyses, are possible in a time trend study of trip generation rates using the data readily available. One level of analysis involves a study of the different per capita rates of trip

generation determined in the various Texas origin-destination surveys. Such an analysis is designed to relate trends in the different origin-destination data in a manner which aids in providing an indication of the change in trip generation rates over time. The annual screenline counts obtained by the Texas Highway Department in the different urban study areas are also utilized in this level of analysis. The annual change in traffic volumes at these locations is partially indicative of changes in per capita urban trip-making characteristics.

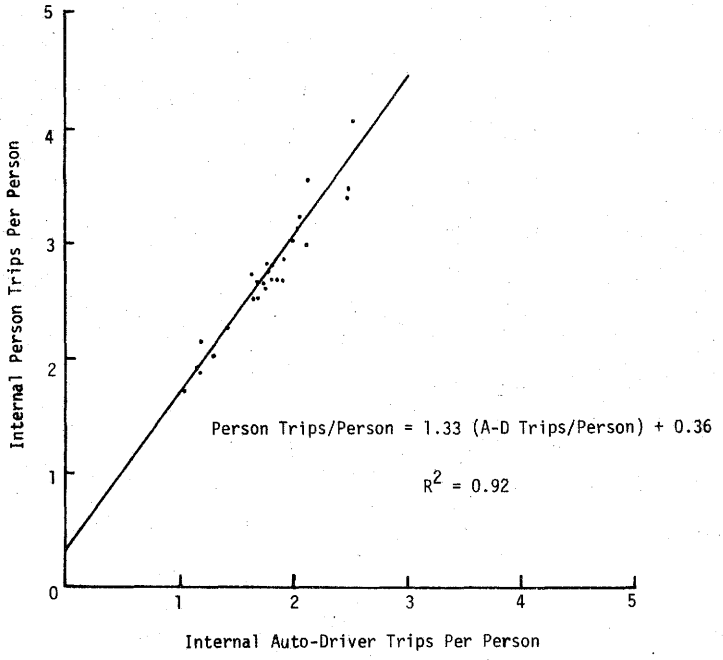

FIGURE 1: Relation Between Person and Auto-Driver Trips Per Person

The other level of analysis concerns an evaluation of more general indicators of statewide urban travel trends such as urban vehicle-miles of travel, urban population, licensed drivers, and registered motor vehicles. This level of analysis identifies general statewide trends in urban travel demand.

The temporal stability of trip generation could be analyzed using O-D travel survey data for two or more points in time from the same urban areas.

However, the dwelling unit data necessary for such an analysis are not available.

HISTORICAL TRENDS IN TRIP GENERATION

I. Analysis of General Statewide Travel Data

Introduction

An evaluation of general statewide travel data can provide an indication of average historical increases in trip making. In determining trends in urban trip making, vehicle-miles of urban travel seem to provide the best indicator of increased total urban trip making. It should be noted that, due to the nature of the travel indicator being considered, the results of the analysis will be weighted toward the travel characteristics of the large urban areas in that these areas generate the majority of urban travel miles.

Analysis*

Between 1960 and 1970, urban vehicle-miles of travel in Texas have been increasing at an annual rate of 6%. This increase might be attributed to:

- increases in urban population;
- increases in average trip length (all trip purposes);
- increases in auto availability (socioeconomic status); and
- increases due to a greater propensity to travel.

Population increases can be accounted for by expressing the increase on a per capita basis. Between 1960 and 1970, urban vehicle-miles per urban resident increased at an average annual rate of 4%. The average trip length for auto driver work trips has been reported to be increasing in various urban areas. Total trip length (miles) was reported to have increased in such cities as Sioux City and Reading having stable or declining populations and increases in average network speed. Previous research has also indicated that average auto driver work trip length (miles) decreased as median family income increased; however, no change in average nonwork trip length was observed.

Urban areas in Texas have historically enjoyed relatively good street systems. Street and freeway improvements have generally kept pace with urban growth in the larger urban areas. Many of the smaller urban areas (less than 100,000 population), have experienced only modest growth and little overall change in average network speeds. Further, average income has increased at a rate above the national average. These and other factors (such as consistently

*Additional discussion of the analytical procedure and results is included in Appendix A.

low population density, commercial development patterns, and social characteristics) suggest that, although average work trip length may have increased in the large urban areas of Dallas, Fort Worth, and Houston, the total average trip length for all urban areas in Texas has changed relatively little between 1960 and 1970.

The increase in auto availability, based on increases in licensed drivers and registered vehicles, accounts for about 2.5% of the annual increase. This implies that, on a total statewide basis, the propensity to travel, between 1960 and 1970, apparently increased at an average rate of about 1.5% per year. It should be noted, however, that individual cities might, and do, deviate significantly from this overall rate. Nevertheless, the possibility that there is a propensity for increased travel of this magnitude, statewide, suggests additional research is warranted to confirm and more definitively quantify its magnitude.

II. Statewide Trends, Screenline Count Analysis

Introduction

The Texas Highway Department has conducted annual screenline counts in the various urban study areas. The data obtained from these counts can provide an indication of historical increases in trip making in that the annual traffic increase at the screenline will be partially the result of increased urban trip making.

The screenlines studied in this analysis generally were located through the center of the urban area. As a result, this analysis will tend to somewhat underestimate the rate of increase in trip generation in that the newer development, which apparently generates trips at a greater per capita rate than the older development, is often located at a considerable distance from the center of the urban area.

Analysis*

Although the screenline analysis, considered independently, does not necessarily afford an accurate indication of greater per capita urban trip making, it is believed that this analysis lends considerable substantiation to the results of the statewide study of general travel data. The results of the screenline analysis indicate that screenline crossing per urban resident in Texas increased at an average annual rate of approximately 3.7%. If the statewide average trip length has not increased significantly, it would appear that the increase in per capita trip making is about 3.7% per annum.

*Additional discussion of the analytical procedure and results is included in Appendix B.

III. Trends in Individual Urban Areas

Introduction

Analyses presented previously determined that internal person and internal auto-driver trips per person increased at a statewide average annual rate of 4%. Since this average rate was calculated based on total urban vehicle-miles of travel, the results are weighted toward the travel characteristics of the large urban areas. Different urban areas within the state undoubtedly exhibit travel trends significantly different from the statewide average trend; failure to consider these differences may result in substantial error in forecasting future trips for any specific urban area.

For the purpose of analyzing trends in individual urban areas, the areas are combined into groups which seem to exhibit similar travel trend patterns. A rate of increase in trip generation is identified for each of these groupings. However, all cities within any one grouping will not necessarily exhibit identical travel trends.

Analysis of Data

An adjustment of the internal person trip per person rate, as determined in the origin-destination studies conducted prior to 1967, is required to correct for discrepencies in the coding of personal driver trips made by pickup truck (refer to Appendix C for the procedure and results of this analysis). All subsequent analyses are based on these adjusted data.

A plot of the adjusted internal person trips per person versus study year for the various urban study areas is presented in Figure 2. The slope determined by this relationship is representative of the average statewide rate of increase in per capita urban trip making; the slope identifies about a 4% annual rate of increase, which is in agreement with the results of analyses presented previously.

Further stratification of the data assists in explaining the variation in trip-making rates between different urban areas. The following variables are

identified as partially explaining differences in the rate of trip making determined in the various urban studies:

- year of study;
- population;
- geographical location;
- per capita auto ownership; and
- per capita median income.

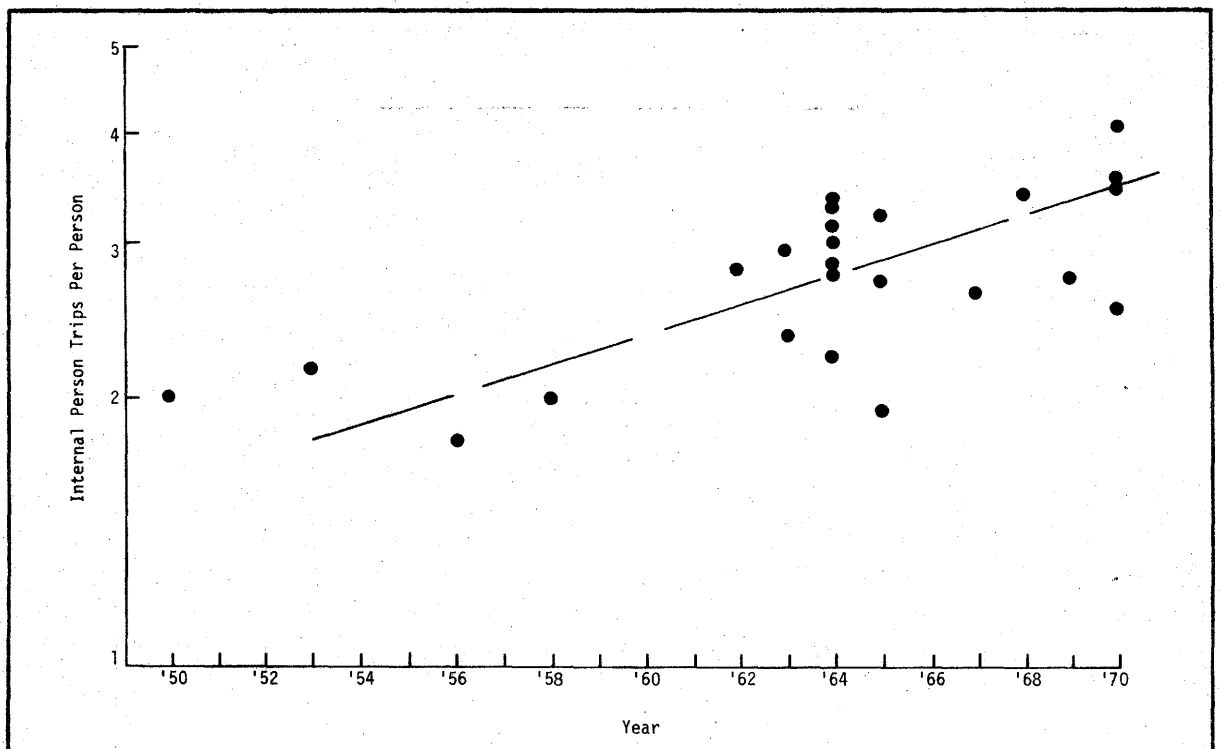

FIGURE 2: Trends In Person Trips Per Person Over Time, Texas Study Areas

An inspection of the study data suggests that an urban area population of approximately 175,000 represents a dividing point between cities exhibiting travel patterns characteristic of "large" and "small" urban areas. A review of the adjusted origin-destination data further suggests that "geographical location" also affects trip generation rates. In general, "North" Texas cities seem to generate different travel patterns than do "South" Texas cities.* Analysis

*Considered as South Texas cities are Brownsville, Corpus Christi, El Paso, Harlingen-San Benito, Laredo, McAllen-Pharr, and San Antonio. The remaining urban study areas are classified as North Texas cities. It should be noted that "geographical location" is a convenient proxy variable for socioeconomic characteristics; "South" Texas cities have historically had lower per capita income levels.

of the combined effects of the variables enumerated above appears to best explain the variation in travel patterns between individual urban areas. A discussion of the independent effect of each variable is provided in Appendix D.

Analysis of Small Urban Areas (population less than 175,000)

Origin-destination surveys for small Texas cities were conducted between 1964 and 1970; therefore, this time period is used in the analysis of historical trends for these cities. "Geographical location" appears to explain much of the variation in trip making over time (Figure 3). This variation is presumably due to socioeconomic characteristics rather than geography per se. Apparently, residents of North Texas cities generally make more trips than residents of South Texas cities; however, the rate of increase in trip making seems to be much greater in the South Texas cities. Figure 3 suggests that per capita trip making, between 1964 and 1970, increased at an annual rate of approximately 5.4% in North Texas cities and at 8.3% in South Texas cities.

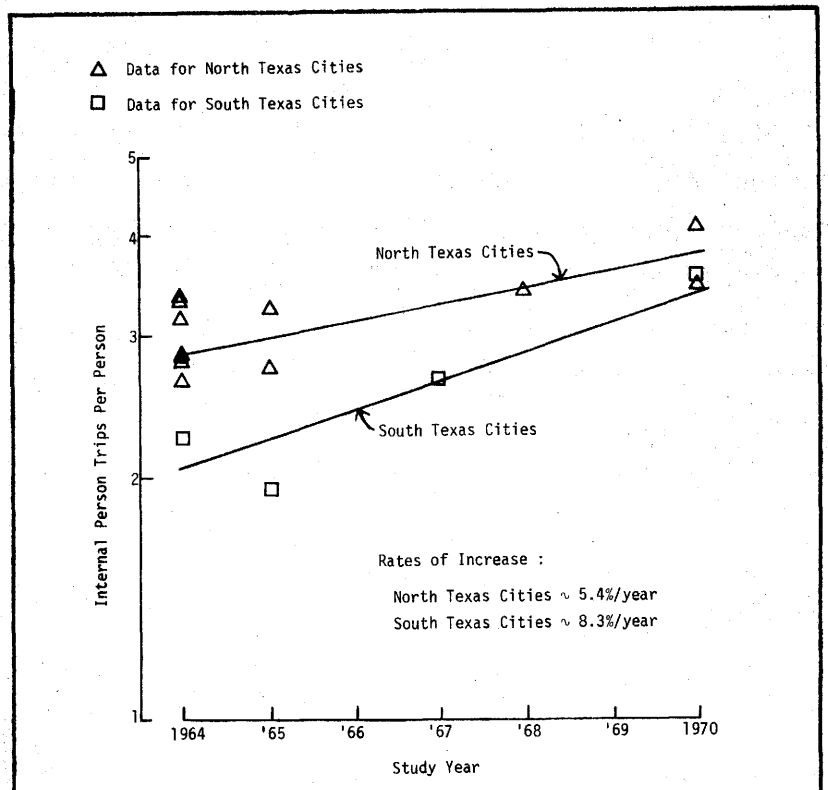

FIGURE 3: Effect of Geographical Location on Per Capita Trip Generation Rates, Urban Areas With Population < 175,000

The different rates of increase in trip making suggested above are generally compatible with shifts in auto ownership in the two geographical areas. Although per capita vehicle ownership, at the time of the respective O-D surveys, was about 0.5 in the Northern cities as compared to 0.4 in the Southern cities, the average annual rate of increase in per capita vehicle ownership was almost 4% in South Texas cities and less than 3% in North Texas cities.

Previous research has generally found income to affect the rate of trip making. As indicated by Figure 4, median per capita income appears to have some relationship to trip-making rates in Texas. Figure 5, which is derived from the data displayed in Figure 4, might be used to provide a first approximation of the increase in per capita trip making between the study year and 1970, given the median income is known for these two time periods.* For example,

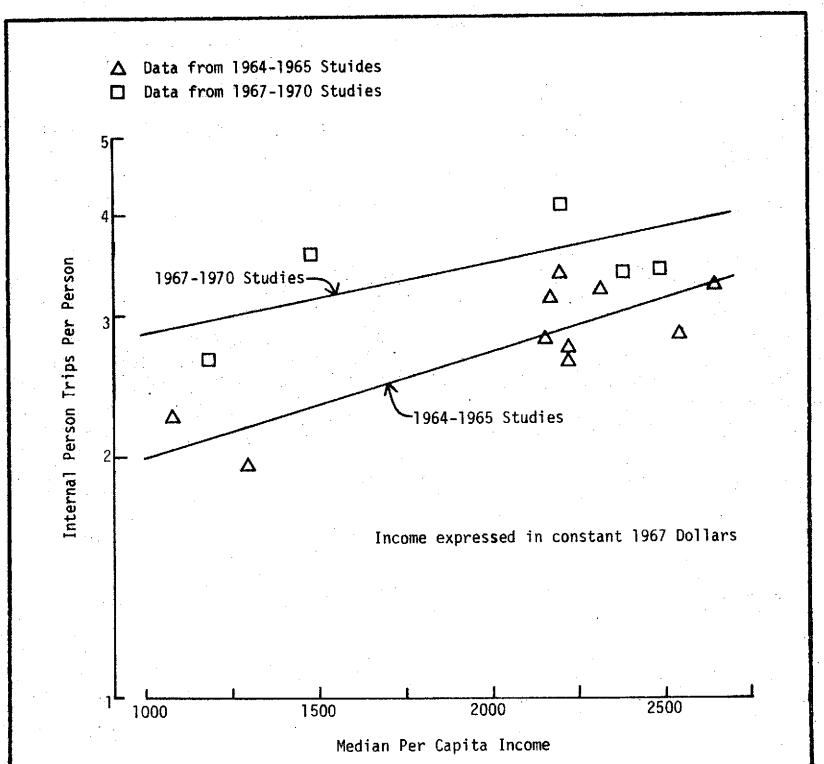

FIGURE 4: Effect of Median Income on Per Capita Trip Generation Rates, Urban Areas With Population < 175,000

*Median incomes for Texas study areas are included in Appendix D.

a city with a median per capita income of $1,000 (constant 1967 dollars) generated about 1.9 person trips per person in 1964. This same city with a median per capita income of $1,500 (constant 1967 dollars) in 1970, might be expected to generate roughly 3.4 person trips per person; this implies that per capita trip generation rates would have increased by 10% per year. Figures 3 and 5 are interrelated since the South Texas cities are generally the low income cities.

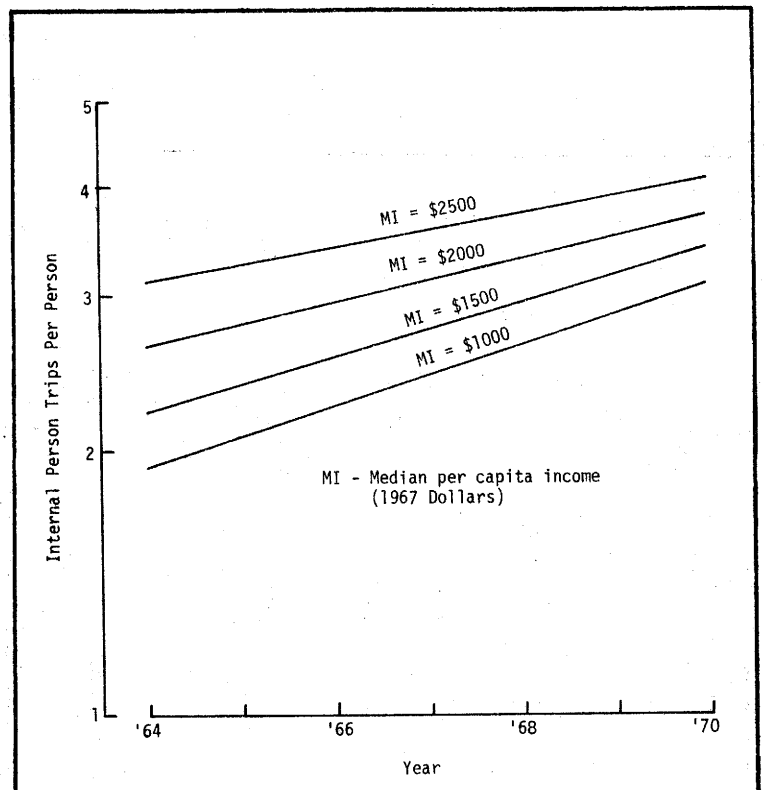

FIGURE 5: Trends In Trip Generation Rates Over Time For Different Income Levels Urban Areas With Population < 175,000

Analysis of Large Urban Areas (population greater than 175,000)

The rate of increase in trip making appears to be approximately 3% for the large urban areas. "Geographical location" appears to explain much of the variation in trip-making rates between the large urban areas (Figure 6). As the figure indicates, residents of the North Texas cities apparently make more trips than residents of South Texas cities. This conclusion is also

generally consistent with vehicle ownership characteristics in the different geographical areas. Per capita vehicle ownership is somewhat higher in North Texas cities (1970 average per capita ownership; 0.57 for North cities, 0.51 for South cities) while the rate of increase in vehicle ownership is comparable for both geographical areas (average increase for 1960-1970; 2.6% in North cities, 2.9% in South cities).

Again, as was the case with the small urban areas, the geographical location (Figure 6) is a convenient proxy for socioeconomic characteristics since median per capita income is higher in the North Texas cities. As indicated by Figure 7, the available data indicate that average trip making during the 1960's apparently increased at an annual rate of approximately 3% in the large urban areas, regardless of geographical or income differences. However, insufficient data are available to develop a graph similar to Figure 5 for the large urban areas.

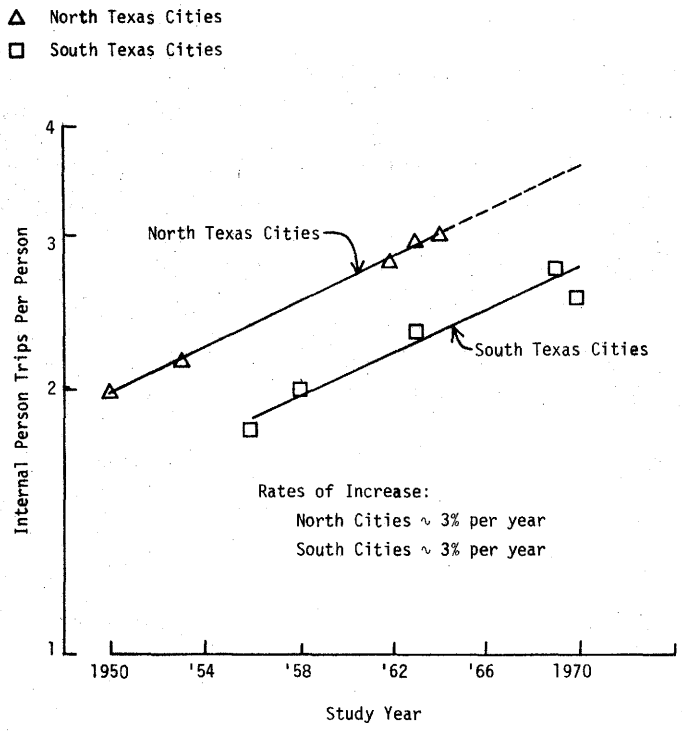

FIGURE 6: Effect of Geographical Location On Per Capita Trip Generation Rates, Urban Areas With Population > 175,000

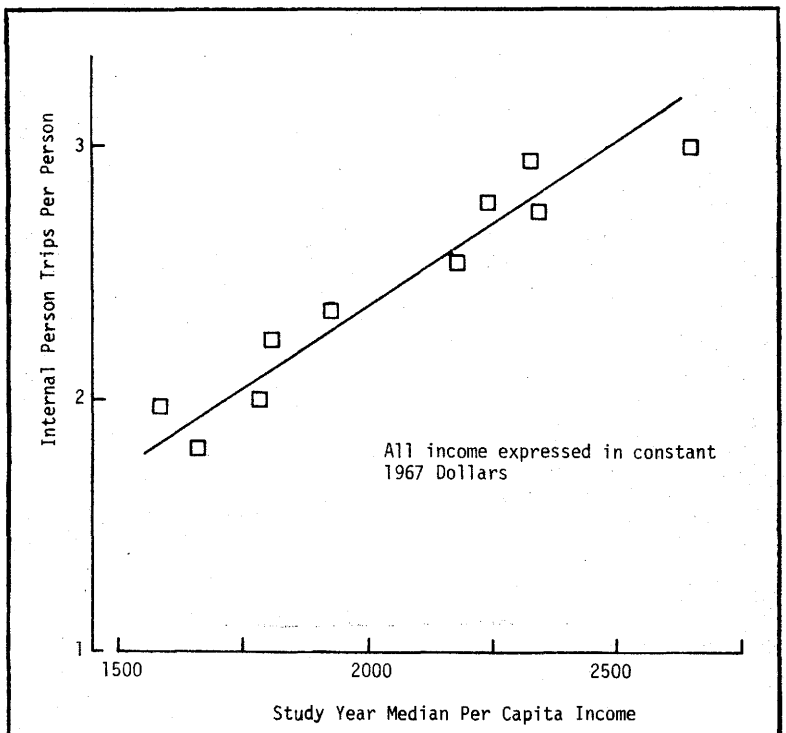

FIGURE 7: Effect of Median Income On Per Capita Trip Generation Rates, Urban Areas With Population > 175,000

Summary of Historical Trends in Individual Urban Areas

Table 1 provides a summary of the historical rates of increase identified for the various classifications of urban areas. These figures indicate that urban areas less than 175,000 population have experienced a sizable annual increase in trip generation rates whereas the large cities have experienced a negligible annual increase.

Type of Urban Area (Location, Population)	(1) Annual % Increase Person trips/person	(2) Annual % Increase auto Availabilty/ Person	(3) Apparent % Increase in Propensity to Travel (1-2=3)
North Texas, Population > 175,000	3.0	2.7	0.3
North Texas, Population < 175,000	5.4	2.5	2.9
South Texas, Population > 175,000	3.0	2.9	0.1
South Texas, Population < 175,000	8.3	5.0	3.3

TABLE 1: Historical Trends In Per Capita Trip Generation, Texas Cities (1960-1970)

IV. Discussion of Origin-Destination Data For Selected Urban Areas

Origin-destination studies have been conducted at two separate points in time in San Antonio, El Paso, and Dallas. A summary of adjusted origin-destination data for these studies is presented in Table 2. The rates of increase for El Paso differs from the average annual 3% increase previously determined as being characteristic of large urban areas. This shows that the rate of increase in trip making for individual cities within a common grouping can and will vary rather substantially.

Urban Area	Internal Person trips/person (Year)	Internal Person trips/person (Year)	Annual % Increase person trips/person
San Antonio	1.80 (1956)	2.76 (1969)	3.2
Dallas	2.00 (1950)	3.01 (1964)	3.0
El Paso	2.00 (1958)	2.54 (1970)	2.0

TABLE 2: Changes in Per Capita Trip Generation Rates Over Time for Selected Urban Areas

Since the original home interview data obtained for the early study in these urban areas are no longer available, a more general approach was used in describing the occurrence of different rates of increase in trip making for the areas. As mentioned previously, changes in median income appear to affect the rate of change in trip making. Comparison of Tables 2 and 3 indicate that trip generation and per capita income increased at the same annual rate for El Paso. However, in San Antonio, trip generation increased faster than per capita income whereas in Dallas, it increased at a lower rate. Given the socioeconomic and transportation characteristics for these cities, these results appear reasonable.

In the absence of the detailed home interview data, the different changes in median income between these areas appear to provide a satisfactory explanation

of the differences in trip generation rates for the two urban areas (Figure 8). It also suggests that median per capita income may be used as a first approximation to adjust the per capita trip generation rates from previously completed O-D surveys.

Urban Area	Median Per Capita Income* (Year)	Median Per Capita Income (Year)	Annual % Increase Median Per Capita Income
San Antonio	1660 (1956)	2400 (1970)	2.7
Dallas	1580 (1950)	3310 (1970)	3.7
El Paso	1740 (1958)	2190 (1970)	2.0

* All income expressed in constant 1967 dollars.

TABLE 3: Changes In Median Per Capita Income Over Time For Selected Urban Areas

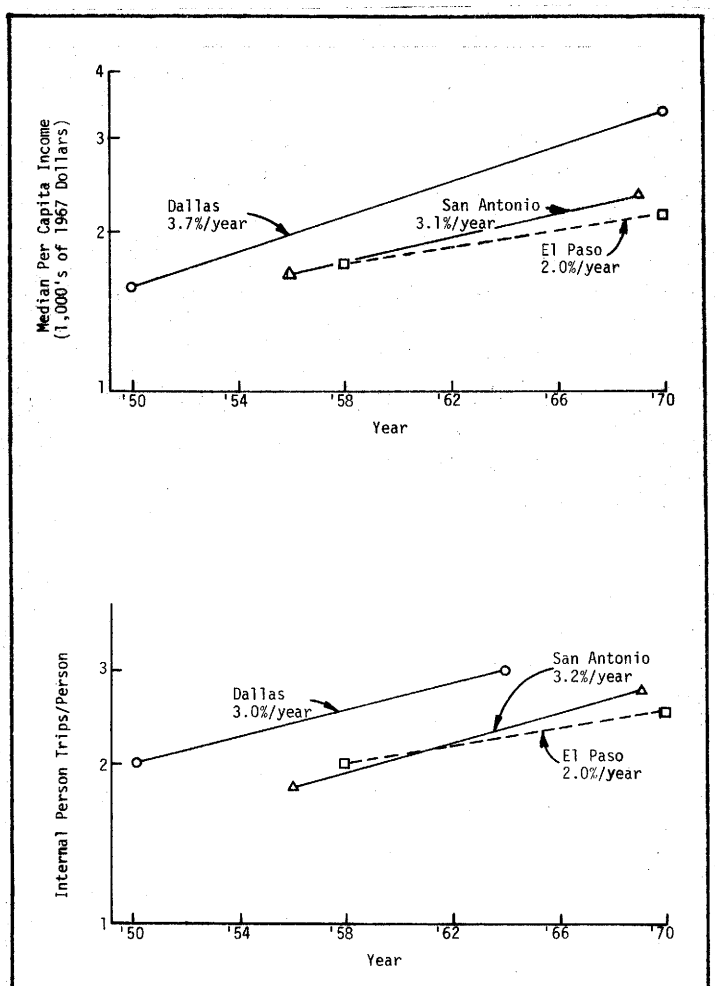

FIGURE 8: Trends In Per Capita Median Income and Trip Generation Rates, Selected Urban Study Areas

FUTURE TRENDS IN TRIP GENERATION
I. Analyses of Statewide Travel Data

Introduction

An evaluation of statewide travel data can also provide an indication of overall increases in per capita urban trip making. This analysis concentrated on projecting trends in the two components, increased auto availability per capita and a greater propensity to travel, previously identified as contributing to increased per capita trip generation.

Analysis*

As documented previously (Historical Trends in Trip Generation, Section I), during the 1960s, the propensity to travel apparently increased at a statewide average annual rate of approximately 1.5%. Shifts in relative income and urban accessibility could greatly alter the rate of increase in the propensity to travel. It is conceivable that this could even become a negative component of future travel if a substantial reversal were to take place in socioeconomic variables (additional discussion relating to the propensity to travel is included in Appendix G). However, based on data currently available, it is not possible to accurately assess the changes which might occur in income levels and urban accessibility. As a result, for planning purposes, it appears reasonable to assume that the propensity to travel will continue to increase in the future at about the same rate it has in the past, or at an annual rate of approximately 1.5%. This rate appears to represent at least a minimum desire for greater individual mobility and, therefore, warrants consideration.

Auto availability per capita, which represents the combined effect of licensed drivers and registered vehicles per capita, historically has increased more rapidly than population (Figure 9). Since a saturation relationship between vehicles per licensed driver has existed in Texas since around 1950, both licensed drivers and registered vehicles have increased at a similar rate. It appears that, by 1980, virtually all eligible drivers will be licensed to drive and, at that time, no further increases in auto availability per capita will occur.

* The data and analytical procedure used in the statewide analysis of future macroscopic data are presented in Appendix E.

Between 1970 and 1980, auto availability per capita can be expected to increase at an annual rate of approximately 1.2% (Table 4).

Therefore, it is estimated that, between 1970 and 1980, person trips per person will increase at a statewide average annual rate of approximately 2.7%; 1.5% of the increase being due to a greater propensity to travel and 1.2% of the increase resulting from an increase in per capita auto availability. From 1980 to 2000, it would appear that person trips per person will increase by approximately 1.5% per year with all of this increase being the result of a greater propensity to travel.

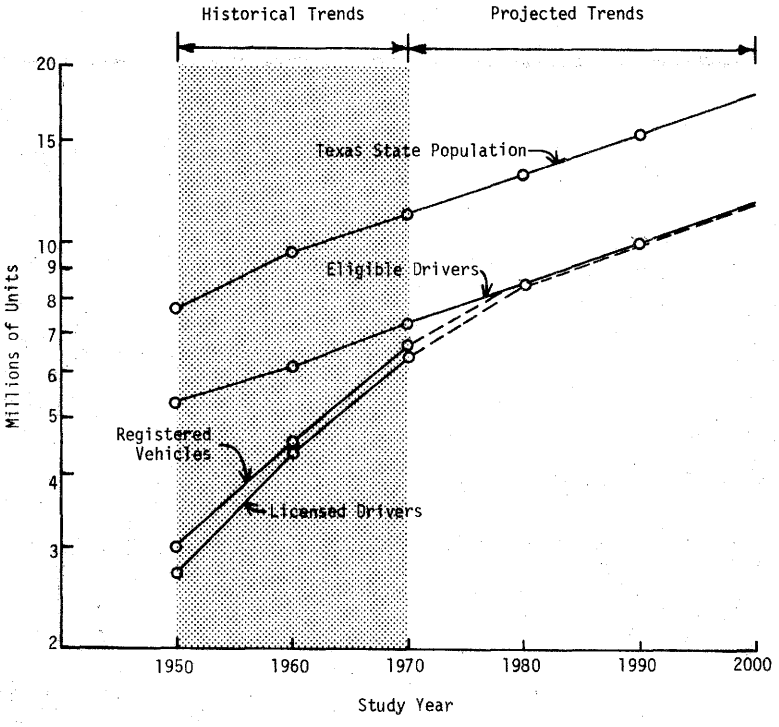

FIGURE 9: Historical and Forecasted Indicators of Urban Travel

Time Period	1950-60	1960-70	1970-80	1980-90	1990-2000
Texas Population	2.2	1.6	1.7	1.7	1.7
Population of Eligible Drivers	1.5	1.8	1.7	1.7	1.7
Licensed Drivers	4.7	4.0	2.9	1.7	1.7
Licensed Drivers Per Capita	2.5	2.4	1.2	0.0	0.0
Registered Vehicles Per Capita	2.2	2.6	1.2	0.0	0.0

TABLE 4: Annual Percent of Increase, Statewide Travel Data

II. Trends In Individual Urban Areas

Introduction

The historical rate of increase in per capita trip generation was shown to vary among the individual urban study areas (Table 1). Population and geographical location, which accounted for socioeconomic differences, were identified as contributing factors in this variation. It is reasonable to also expect a variation in the future rates of increase in trip making between different urban areas.

Analysis*

The increase in per capita trip generation is attributed to both an increase in auto availability per capita and a greater propensity to travel. The historical increase in trip generation and the components of this increase were presented in Table 1.

Auto availability per capita is approaching a saturation level in all urban areas within Texas. It appears that, by 1980, a saturation level of vehicle ownership will exist in the various urban areas. However, the rate of increase in auto availability per capita which will occur between 1970 and 1980 will differ among the different areas if saturation vehicle ownership is to be realized (Table 5).

Historically, the increase in travel resulting from a greater propensity to travel has varied between the different urban areas (Table 1). The variations in the propensity to travel present several interesting considerations in explaining both historical travel trends and in projecting future trends. A discussion concerning the propensity to travel is included in Appendix G.

It is estimated that the propensity to travel, or the desire to increase individual mobility, will increase in the future at an average annual rate of 1.0% in the large urban areas and at 2.0% in the smaller urban areas within the State. These rates of increase will account for at least a minimum desire for increased individual mobility. The future rates of increase in urban per capita

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* Additional discussion of the data and analyses presented in this section is included in Appendix F.

trip generation resulting from both greater auto availability and an increased propensity to travel are presented in Table 5.

Component of Increased Travel Per Person	Type of Urban Area							
	Large North		Small North		Large South		Small South	
	1970 to 1980	1980 to 2000	1970 to 1980	1980 to 2000	1970 to 1980	1980 to 2000	1970 to 1980	1980 to 2000
Auto Availability/Person	1.9	0.0	1.5	0.0	2.9	0.0	3.3	0.0
Propensity to Travel	1.0	1.0	2.0	2.0	1.0	1.0	2.0	2.0
Total Annual % Increase	2.9	1.0	3.5	2.0	3.9	1.0	5.3	2.0

TABLE 5: Projected Annual Percent of Increase In Per Capita Trip Generation, Texas Cities

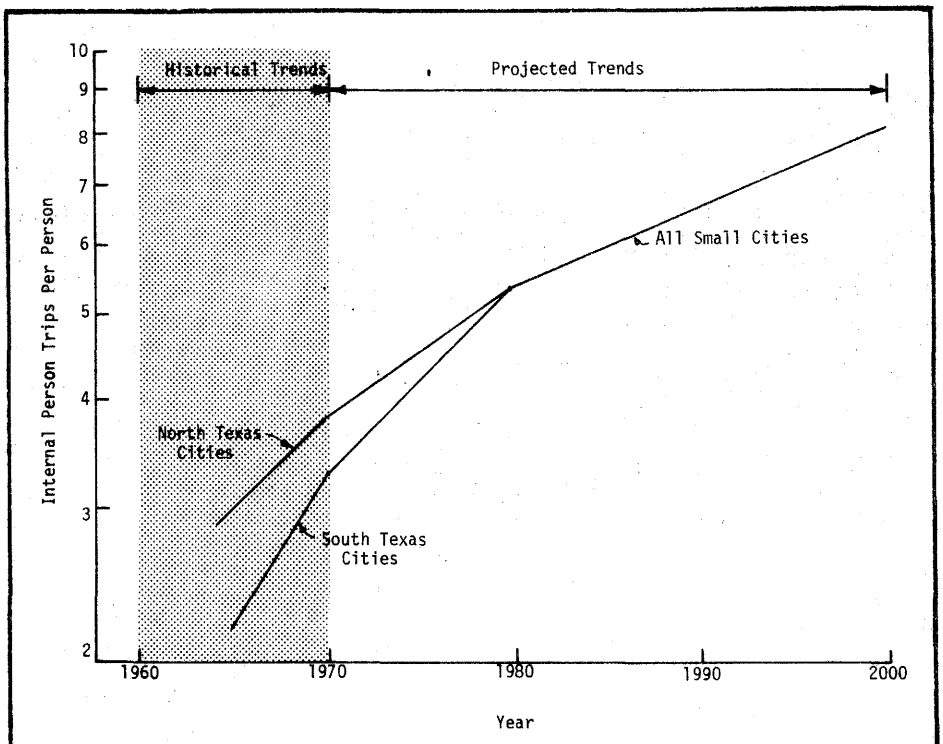

FIGURE 10: Projected Rates of Per Capita Trip Generation For "Typical" Small Urban Areas (Population < 175,000)

By applying the rates of increase presented in Table 5 to the historical trends in trip making identified previously, an indication of the future rate of trip making for a "typical" urban area in the different groups can be obtained (Figures 10 and 11). However it should be emphasized that the rate of trip making for any specific urban area within a grouping can vary from the average rate of trip making for the group.

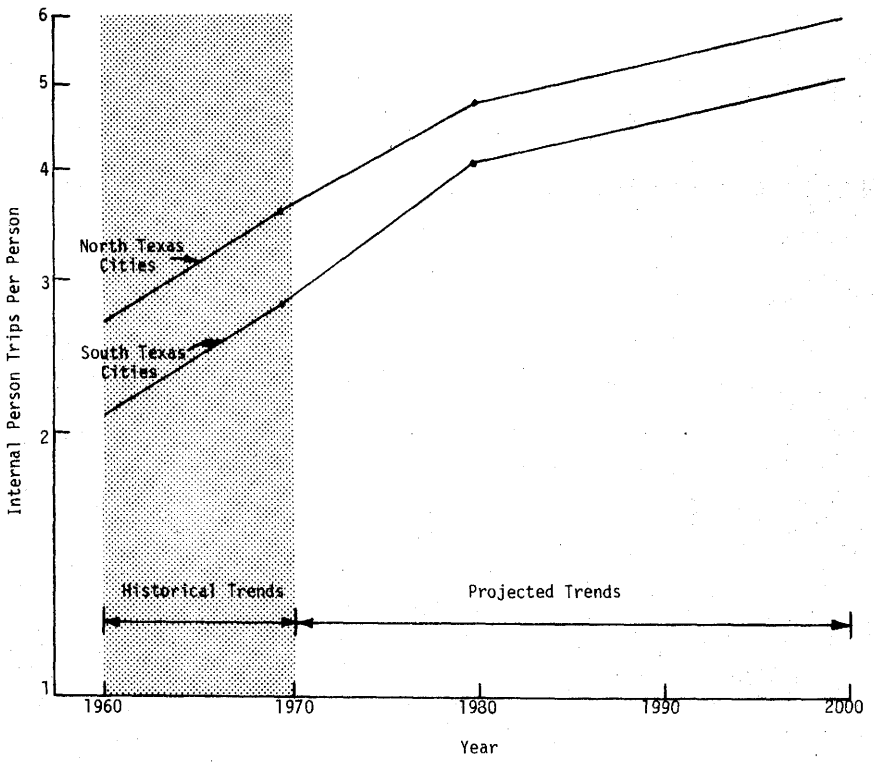

FIGURE 11: Projected Rates of Per Capita Trip Generation For "Typical" Large Urban Areas (Population > 175,000)

CONCLUSIONS

The results of this preliminary analysis indicate that internal person trips per person and internal auto-driver trips per person for urban areas within Texas have been increasing historically and can be expected to continue increasing in the future. These increases in per capita travel demand are the result of changes in socioeconomic characteristics and a greater propensity to travel. The various urban study areas have significant differences in the numerical trip generation rate and in the rate of increase in per capita trip generation. A review of data from Texas origin-destination surveys indicated that at least two factors, population and "geographical location"[1], explain much of the variation in the rate of per capita trip making between the various urban areas. The following classifications[2] of urban areas were found to exhibit generally similar travel characteristics:

1. North Texas cities, population greater than 175,000.
2. North Texas cities, population less than 175,000.
3. South Texas cities, population greater than 175,000.
4. South Texas cities, population less than 175,000.

The rate of increase in trip making apparently does vary between these classifications of urban areas (Table 6). Between 1960 and 1970, annual rates of increase as low as 3% were identified for large urban areas and annual rates of increase as high as 8.3% were found to be characteristic of certain smaller urban areas. A decline in the rate of increase in per capita trip making is expected since a saturation level of vehicles per capita is projected to occur within the urban areas in Texas by around 1980. After 1980, additional vehicle ownership is expected to result solely from increases in population and should not affect the rate of per capita trip making.

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[1] Again, "geographical location" apparently becomes a factor in that it is a proxy variable for differences in income levels, auto ownership levels, and other socioeconomic characteristics between the urban areas.

[2] Considered as South Texas cities are Brownsville, Corpus Christi, El Paso, Harlingen-San Benito, Laredo, McAllen-Pharr, and San Antonio. The remaining urban study areas are classified as North Texas cities.

Time Period	Type of Urban Area				
	Weighted Statewide Average	Large North Cities	Small North Cities	Large South Cities	Small South Cities
1960-1970	4.0	3.0	5.4	3.0	8.3
1970-1980	2.7	2.9	3.5	3.9	5.3
1980-2000	1.5	1.0	2.0	1.0	2.0

TABLE 6: Estimated Annual Percent of Increase In Person Trips Per Person, Texas Cities

A decrease in socioeconomic levels in the future could reduce the level of trip making. Changes in taxation, inflation, and the price of gasoline and/or parking could, conceivably, decrease the disposable income of the urban population. If this does occur, persons may decide to spend less on transportation (or obtain less transportation at the same cost), with the result being a decrease in trip making.

Persons in any given socioeconomic level apparently make more trips today than they have in the past. This occurrence, referred to as an increased propensity to travel, is the result of a changing lifestyle and suggests a desire on the part of the urban population for a greater individual mobility.

The propensity to travel is a dynamic quantity and is partly dependent on the level of urban accessibility. The rates of increase presented in Table 6 assume that adequate transportation improvements will be provided in the future so as to maintain a high level of urban accessibility. If such improvements are not provided, the propensity to travel will probably decrease. If these constraints do develop, a latent demand for travel will be generated in the urban areas. There is some indication that this latent demand may already exist or be developing in some portions of the larger Texas urban areas. If latent demand is created by mobility constraints, it is reasonable to assume that future highway facilities will continue to experience congestion levels in excess of those predicted using conventional forecasting techniques.

In general, unanticipated changes in any of the following could result in different rates of increased trip making than estimated in this report:

1. a decrease in socioeconomic conditions resulting in lower trip making rates;

2. urban accessibility not maintained at a level adequate to serve travel desire resulting in a decreasing, rather than an increasing, propensity to travel; and
3. a saturation level in per capita trip making occurs before the year 2000.

The average rates of increase identified herein result in higher design year trip generation rates than those historically used in forecasting future rates of trip generation (Table 7). The apparent underestimation of internal vehicle trips per capita appears to be approximately 30% for the design year using conventional procedures. Additional research, requiring extensive data collection and analysis, will be necessary to identify a breakdown of total trips according to trip purpose and to more precisely identify rates of change in trip generation for individual urban areas.

Study Area	Internal Vehicle Trips Per Person*		
	Study Year Rate	Forecast Year Trip Rate	
		Transportation Study	Rate Based On Research Reported Herein
Dallas-Ft. Worth	2.1 (1965)	2.9 (1985)	3.9 (1985)
Galveston	1.9 (1965)	2.8 (1985)	3.8 (1985)
Waco	1.9 (1965)	2.9 (1985)	3.8 (1985)
Victoria	2.9 (1970)	3.9 (1990)	5.0 (1990)

TABLE 7: Comparison of Per Capita Generation Rates Forecasted In Selected Transportation Studies and Rates Forecasted Using Recommended Procedure

* Internal vehicle trips per person also correlate with internal person trips per person. These generation rates are related as follows: Internal Person Trips Per Person = 1.19 (internal vehicle trips/person) + 0.24; $R^2 = 0.91$

GLOSSARY OF TERMS

Survey Area: The geographical area selected for the origin and destination survey.

Internal Trip: A trip with both the origin and destination located inside the survey area.

Person Trip: One-way travel of a single person between two points; as an auto driver, or as an auto, truck, taxi, or bus passenger. Pickup truck driver trips for personal business are also included.

Auto-Driver Trip: One-way travel between two points made by an individual driving an automobile or driving a pickup truck for personal business.

Vehicle Trip: One-way travel of a motor vehicle between two points.

Propensity to Travel: Changes in travel demand over time within any one socioeconomic level resulting from a changing lifestyle; changes in customs, cultural habits, personal preferences, and level of mobility will influence the propensity to travel. This is accounted for by the cultural component of trip generation.

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APPENDICES

APPENDICES

Table of Contents

Appendix A 31
Analysis of Historical Statewide Travel Data

Appendix B 33
Screenline Count Analysis

Appendix C 36
Pickup Truck Correction Analysis

Appendix D 39
Variables Influencing Trip Generation Rates

Appendix E 46
Analysis of Future Statewide Travel Data

Appendix F 49
Future Trends In Individual Urban Areas

Appendix G 51
The Propensity to Travel, A Discussion

APPENDIX A

Analyses of Historical Statewide Travel Data

Urban vehicle miles of travel seem to provide the best statewide indicator of changes in the rate of urban trip making. Increases in urban vehicle miles of travel can be attributed to:

1. increases in urban population;
2. increases in the average urban trip length (all trips purposes);
3. increases in auto availability per capita. This component is a function of both increases in licensed drivers and motor vehicles per capita; and
4. increases in the number of trips resulting from a greater propensity to travel.

The effect of population increases can be accounted for by reducing vehicle miles of travel per urban resident (Table A-1). This indicator of travel increased at an annual rate of 4% during the 1960s.

Year	Urban Miles of Travel (MVM)	Urban Population	Urban Miles of Travel Per Urban Resident
1960	21,500	7,186,000	3,000
1970	39,201	8,921,000	4,400

TABLE A-1: Urban Travel Per Urban Resident

Limited Texas data from the San Antonio study indicate that average trip length apparently has not increased over time in the state. Origin-destination data were used to determine an average trip length of 3.7 miles in 1956 and 3.8 miles in 1969. This suggests that the entire increase in urban vehicle-miles per urban resident is apparently the result of a greater rate of per capita urban trip making.

Data pertaining to vehicle availability are provided in Table A-2. Licensed drivers per capita have increased at an annual rate of approximately 2.5% since 1950. Vehicles per capita increased at approximately 2.5% during the 1960s. The

similar increase in licensed driver per capita and motor vehicles per capita implies that a greater auto availability apparently accounts for 2.5% of the 4% annual increase in urban travel miles per urban resident. The annual increase in trip making and the components of this increase are presented in Table A-3.

Year	Texas Population	Licensed Drivers		Registered Vehicles	
		No.	Per Capita	No.	Per Capita
1960	9,580,000	4,352,000	0.45	4,456,000	0.47
1970	11,197,000	6,380,000	0.57	6,693,000	0.60

TABLE A-2: Change in Per Capita Vehicle Availability

Component of Increased Trip Making	Time Period
	1960-1970
Greater Auto Availability	2.5
Greater Propensity to Travel	1.5
Total Annual Increase	4.0

TABLE A-3: Annual Percent of Increase In Trip Making Per Capita, 1960-1970

APPENDIX B
Screenline Count Analysis

Introduction

The Texas Highway Department has conducted annual screenline counts in the various urban study areas. The data obtained from these counts can provide an indication of historical increases in trip making since the annual traffic increase at the screenlines will be partially the result of increased urban trip making.

However, for the reasons enumerated below, the screenline analysis should not be considered to provide a highly accurate indicator of greater urban trip making:

1. the screenlines used in this analysis are generally located through the center of the urban area while newer development is generally occurring at some distance from the center of the urban area. Since the newer development is apparently generating a greater number of trips per person than the older development, it would appear that the screenline analysis will slightly underestimate the rate of increased trip making;
2. new streets and highways constructed across the screenline may serve a latent demand, resulting in a greater increase in traffic across the screenline than would otherwise be expected; and
3. difficulty is encountered in estimating the urban population whose travel patterns may influence the screenline count.

As a result, the effectiveness of a screenline in measuring increased urban trip making would appear to be highly dependent on the characteristics of each individual urban area. Consequently, these screenline counts will not necessarily provide an accurate indication of either increased trip making in any one urban area or of differences in trip making between urban areas. It appears that the analysis of screenline counts can, at best, be assumed to provide some indication of the average statewide increase in

urban trip making. However, the results obtained from this analysis should provide a substantiation of the results obtained in the previous analysis of statewide data (Appendix A).

Analysis Techniques

Those urban study areas having the following characteristics were selected for the screenline analysis:

1. screenline counts were conducted prior to and during 1970; and
2. the population of the urban area containing the screenline could be estimated with reasonable accuracy from available census data.

The initial screenline count and the 1970 base year count for each of the study areas were used in the analysis. Using straight line interpolation between the 1960 and the 1970 census data, the population of the urban area at the time of both the initial and the 1970 count was estimated. The screenline count data and the population data for each study area were plotted versus time on semilogarithmic paper; a straight line on such a plot represents a constant annual percentage of change.

In order to eliminate the effect of changes in urban population from the analysis, the screenline counts at the two points in time were divided by their corresponding urban population. This procedure yields screenline crossings per person for two separate points in time. The annual percentage of increase (decrease) in screenline crossings per person between the initial count and the 1970 count was then determined.

Since trip length in Texas apparently has not increased over time, the rate of increase in screenline crossings per urban resident should be equivalent to the annual increase in person trips per person. The average annual statewide increase in screenline crossings per urban resident was 3.7 percent. This tends to substantiate the results of analyses presented in Appendix A. The data used and the results of the screenline analysis are summarized in Table B-1.

Study Area, Year	Screenline Count		Estimated Population		Screenline Crossings Per Person		Annual % increase
	Initial Year	1970	Initial Year	1970	Initial Year	1970	Crossings/ Person
Abilene, 1965	98,440	114,270	90,000	89,653	1.09	1.27	3.1
Amarillo, 1964	112,010	110,350	134,000	127,010	0.84	0.87	0.6
Austin, 1962	94,110	167,500	200,000	251,808	0.47	0.67	4.5
Corpus Christi, 1961	130,270	157,480	171,000	204,525	0.76	0.76	0.0
Dallas-Ft. Worth, 1964	94,520	150,315	1,711,000	2,043,638	0.055	0.074	5.1
El Paso, 1963	135,550	165,190	290,000	322,261	0.47	0.51	1.2
Galveston, 1964	49,730	65,190	65,000	61,809	0.77	1.05	5.3
Harlingen-San Benito, 1965	21,760	30,460	53,000	48,679	0.41	0.62	8.6
Houston, 1960	401,200	784,250	1,243,158	1,741,912	0.32	0.45	3.5
JORTS, 1963	28,240	41,840	207,000	197,747	0.14	0.21	6.0
Laredo, 1964	45,120	73,990	64,000	69,024	0.71	1.07	7.1
Lubbock, 1964	115,460	114,270	137,000	149,101	0.84	0.77	-1.4
McAllen-Pharr, 1968	51,240	54,630	65,000	66,508	0.79	0.82	1.0
San Angelo, 1964	80,470	103,030	60,000	63,884	1.34	1.61	3.1
San Antonio, 1964	364,090	480,450	614,000	654,153	0.59	0.73	3.6
Sherman-Denison, 1968	134,120	162,830	53,000	53,984	2.53	3.02	9.3
Texarkana, 1965	44,500	58,960	49,000	50,300	0.91	1.17	5.2
Tyler, 1964	83,260	97,680	54,000	57,770	1.54	1.69	1.6
Waco, 1964	63,640	81,390	96,000	95,326	0.66	0.85	4.3
Wichita Falls, 1964	65,200	71,600	100,000	97,564	0.65	0.73	1.9
Mean, Annual Percent Increase, Screenline Crossings/Person							3.7

TABLE B-1: Summary of Screenline Count Analysis

APPENDIX C
Pickup Truck Correction Analysis

Introduction

Driver trips for personal purposes made by pickup truck have not been recorded in a similar manner in the various Texas origin-destination surveys. Prior to 1967, such trips were coded as truck driver trips and, hence, are not reflected in either the person or auto-driver trip rates. Since 1967, these trips have been coded as if they were auto driver trips and, consequently, are included in both the person and auto-driver trip rates.

In order to avoid misinterpretation of the data analyses, a procedure was developed to partially adjust for this discrepancy. The pickup truck coding techniques used since 1967 appear to provide a more accurate treatment and, as a result, trip-making rates determined from the earlier studies are adjusted to correct for the discrepancy.

Sufficient data are not available from which a highly accurate adjustment can be made for any specific urban area. However, since in the analyses the data for several urban areas are combined to determine average rates of increase for these areas, an error in any specific data point should not significantly alter the results.

Adjustment Procedure

1. The Texas Highway Department estimated the number of autos and trucks in certain study areas at the time of the study (Table C-1). Total trucks, on the average, represent approximately 13% of total autos in the various study areas. However, the wide range of percentages shown in Table C-1 emphasizes the approximate nature of the analysis. To avoid underestimation of person trips, trucks are assumed to constitute 15% of total autos.
2. From the 1967 Census of Transportation (West-South Central Division), it was found that 77.4% of all trucks are either pickup or panel trucks; 82% of these are pickup trucks. Therefore, pickup trucks constitute about two-thirds of total trucks.
3. From the 1967 Census of Transportation, it was determined that 50% of pickups

were primarily personal use vehicles. These pickups were assumed to follow a travel pattern identical to the private auto (i.e., the same number of driver trips per vehicle).

4. It was assumed that 40% of the remaining pickups, although primarily not personal use vehicles, serve some personal trips. It was further assumed that these vehicles made 50% as many personal trips as an auto.

5. The results of the described analysis are presented in Table C-2. These values should not be considered as highly accurate for any specific study area, although they should partially account for the discrepancy in the coding of pickup truck trips. From these results, it can be concluded that, in the absence of more detailed information, applying the pickup correction to the early study areas appears to generally increase person trips per person by approximately 4%.

Study Area, Year	Autos	Trucks	Trucks as a % of Autos
Abilene, 1965	39,899	5540	14
Austin, 1962	77,869	4992	6
Brownsville, 1970	16,810	2640	16
Corpus Christi, 1963	61,743	2664	4
JORTS, 1963	107,863	13780	13
Lubbock, 1964	61,359	6544	11
San Angelo, 1964	24,670	4464	18
Sherman-Dension, 1968	30,759	3941	13
Victoria, 1970	18,311	4204	23
Wichita Falls, 1964	41,050	3752	9
Average			13

TABLE C-1: Auto and Truck Registration, Texas Study Areas

Study Area	Population	Total Person Trips (Original O-D)	Additional Person Trips (Adjusted for Pickup Factor)	Total Adjusted Person Trips/ Person
Abilene	100,865	312,334	15,010	3.24
Amarillo	156,356	493,925	22,148	3.30
Austin	209,608	558,360	25,615	2.79
Brownsville	65,018	232,557	- 0 -	3.57
Bryan-College Station	57,008	198,245	- 0 -	3.48
Corpus Christi	196,093	443,436	19,670	2.36
Dallas, 1950	533,606	1,040,205	27,000	2.00
Dallas-Ft. Worth, 1964	1,821,468	5,259,850	232,149	3.01
El Paso, 1958	268,968	517,456	21,390	2.00
El Paso, 1970	362,794	919,490	- 0 -	2.54
Galveston	167,842	459,728	19,035	2.85
Harlingen-San Benito	67,653	126,555	5,619	1.95
Houston, 1953	878,629	1,850,327	72,122	2.18
JORTS	314,714	892,001	39,109	2.96
Laredo	64,311	139,578	5,291	2.25
Lubbock	152,780	411,826	20,425	2.83
McAllen-Pharr	79,413	212,018	- 0 -	2.67
San Angelo	63,438	169,944	8,044	2.81
San Antonio, 1956	601,586	1,041,260	43,583	1.80
San Antonio, 1969	825,843	2,280,492	- 0 -	2.76
Sherman-Denison	62,121	212,312	- 0 -	3.42
Texarkana	64,278	168,067	7,904	2.74
Tyler	64,512	197,143	8,973	3.19
Victoria	45,863	188,001	- 0 -	4.10
Waco	132,350	332,815	15,444	2.63
Wichita Falls	107,704	349,263	15,383	3.39

TABLE C-2: Adjusted Person Trips Per Person, Study Year

APPENDIX D
Variables Influencing Trip Generation Rates

Introduction

The following variables have been identified as partially explaining variations in the rates of trip making determined in the different urban studies:

1. year of study;
2. population;
3. geographical location;
4. per capita auto ownership; and
5. per capita median income.

A brief discussion of the individual effect of each of these variables is presented below.

Study Year

The fact that study year accounts for some of the variation in the rate of trip making (Figure D-1) indicates that time trends do exist in per capita trip generation rates. Such rates show an increase in per capita trip making over time.

Population

Population assists in explaining some of the variation in trip-making rates (Figure D-2). However, the results indicated in Figure D-2 are somewhat misleading in that the year in which the study was conducted is also a variable in the relationship depicted. The studies in the large urban areas were generally conducted at an earlier date than were the studies in the smaller urban areas.

Geographical Location

For purposes of analysis, Texas study areas were divided into "North" Texas and "South" Texas cities. Such a geographical division explains considerable variation in the data (Figure D-3). This geographical difference, however, appears to be reflecting socioeconomic differences between the different areas. Such Texas cities have both lower income levels and lower auto ownership rates, both of which

contribute to the lower per capita trip making in these areas. Further discussion of the effect of these variables is included below.

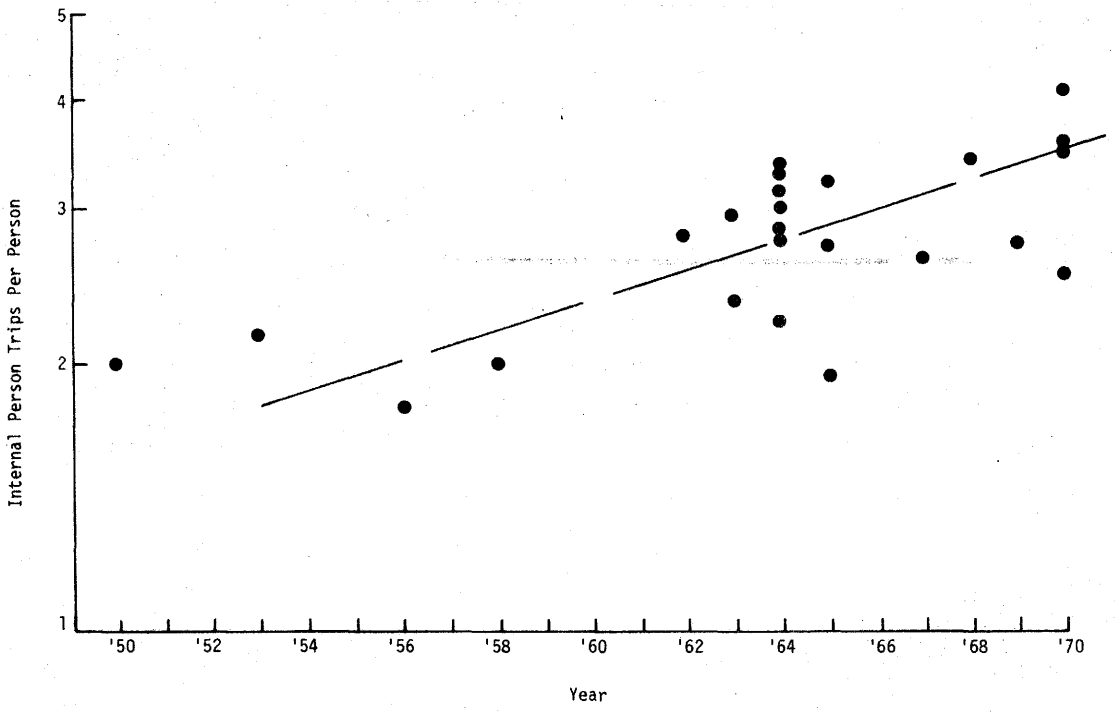

FIGURE D-1: Trends In Person Trips Per Person Over Time, Texas Study Areas

Per Capita Auto Ownership

As would be expected, per capita vehicle ownership influences per capita trip making (Figure D-4). Those urban areas identified as having less than 0.5 vehicles per capita are generally either "South" Texas cities or cities with early study dates. Table D-1 presents an estimated value of vehicles per capita for the various study areas.

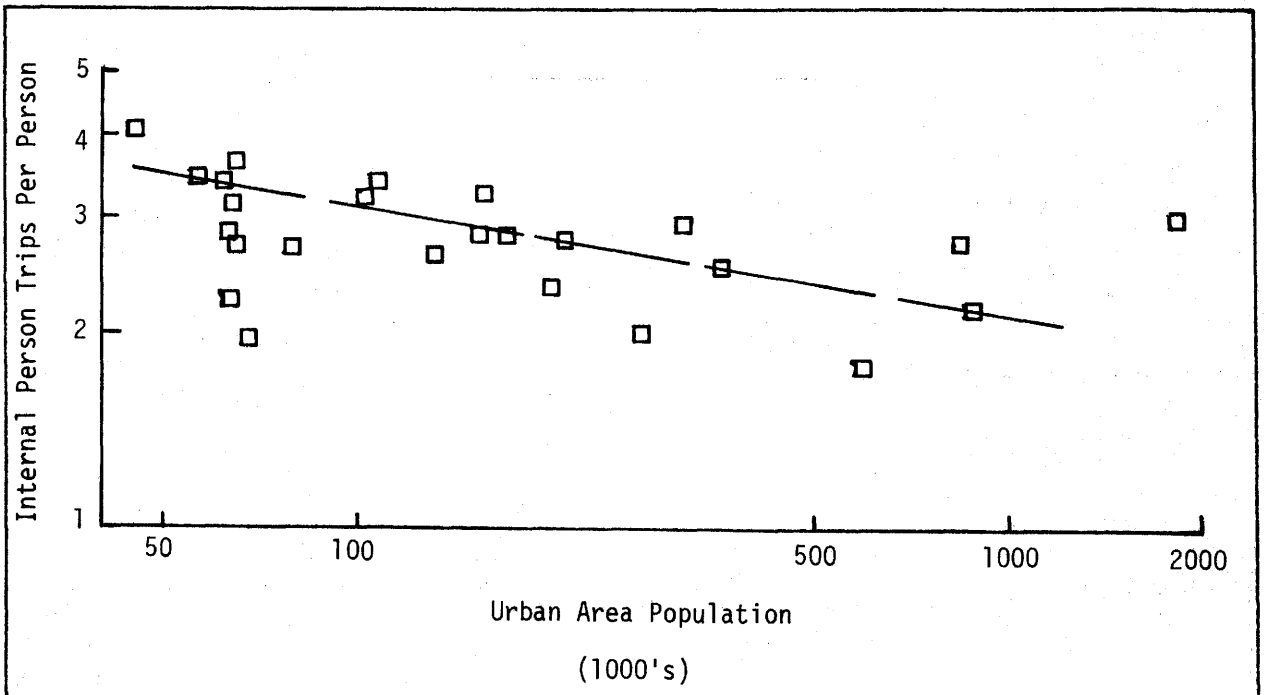

FIGURE D-2: Effect of Urban Population On Per Capita Trip Generation Rates

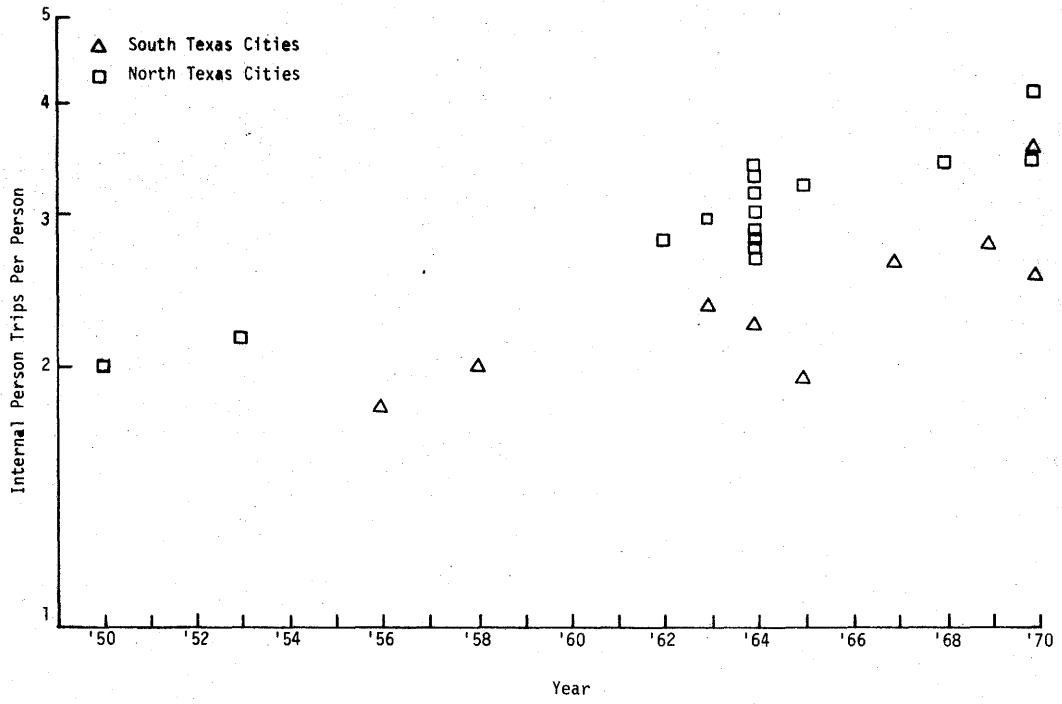

FIGURE D-3: Effect of Urban Location On Per Capita Trip Generation Rates

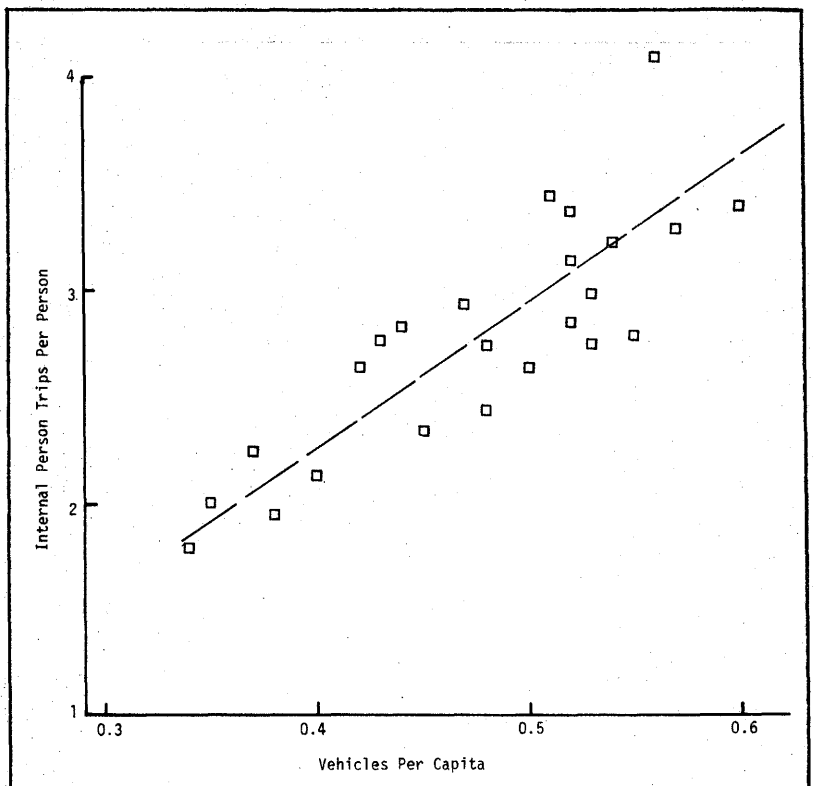

FIGURE D-4: Effect of Vehicle Ownership On Per Capita Trip Generation Rates

Study Area, Year	Registered Vehicles Per Capita (Based on County Data)		Annual % Increase Vehicles/ Capita
	1960	1970	
Abilene, 1965	0.48	0.60	2.2
Amarillo, 1964	0.50	0.67	3.0
Austin, 1962	0.40	0.54	3.1
Brownsville, 1970	0.31	0.46	4.0
Bryan-College Station, 1970	0.39	0.51	2.8
Corpus Christi, 1963	0.40	0.55	3.2
Dallas-Ft. Worth, 1964	0.48	0.60	2.2
El Paso, 1970	0.37	0.48	2.8
Galveston, 1964	0.39	0.52	3.0
Harlingen-San Benito, 1965	0.31	0.46	4.0
Houston, 1953 & 1960	0.46	0.57	2.2
JORTS, 1963	0.43	0.57	2.8
Laredo, 1964	0.28	0.50	6.0
Lubbock, 1964	0.48	0.58	2.0
McAllen-Pharr, 1967	0.31	0.47	4.2
San Angelo, 1964	0.50	0.62	2.2
San Antonio, 1969	0.38	0.49	2.7
Sherman-Denison, 1968	0.49	0.63	2.5
Texarkana, 1965	0.44	0.62	3.5
Tyler, 1964	0.46	0.61	2.8
Victoria, 1970	0.44	0.56	2.5
Waco, 1964	0.44	0.58	2.8
Wichita Falls, 1964	0.48	0.61	2.5
Average			3.0
Weighted Average			2.6

TABLE D-1: Increases In Vehicle Ownership

Per Capita Median Income

In Texas, median income is closely related to city location. South Texas cities generally have lower per capita income, and those areas with lower incomes generate fewer trips (Figure D-5). Estimated per capita income in

constant dollars for the various study areas is included in Table D-2.

Income has historically been increasing and has resulted in greater auto ownership and greater trip making. It is possible, however, for future increases in taxation and inflation to bring about a decrease in disposable income in the future. If such does occur, future income changes could, conceivably, become a negative component of future travel demand.

Future increases in income will not necessarily bring about future increases in trip making. Once income is sufficient to create a saturation level of vehicle ownership, the effect of further increases in income may not greatly increase the rate of trip making. Once this income level is attained, the nature of trips might change but the absolute number of per capita trips may not change appreciably.

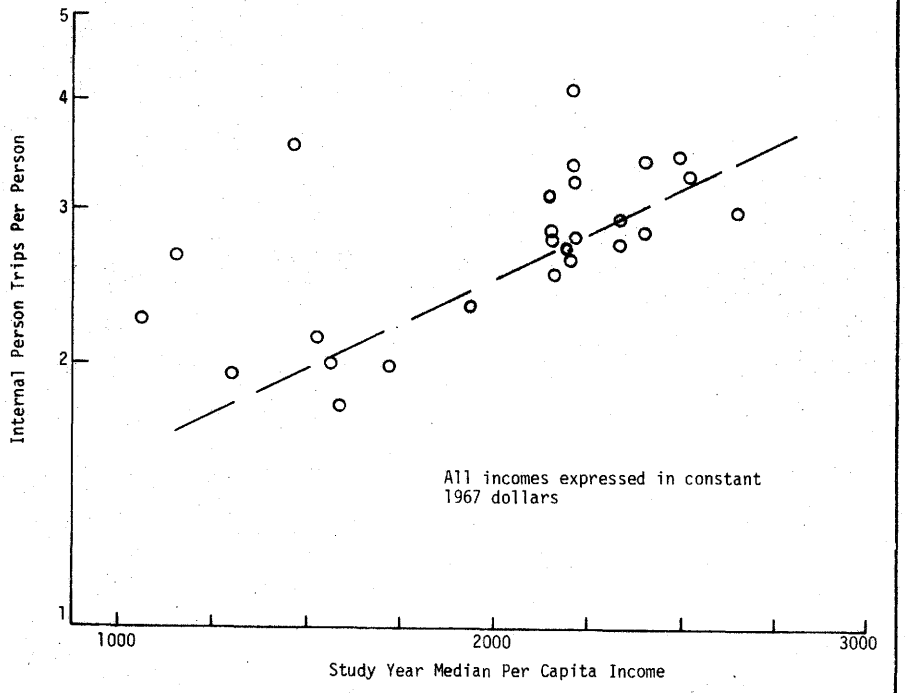

FIGURE D-5: Effect of Median Income On Per Capita Trip Generation Rates

Study Area, Year	Study Year Income* (dollars)	1970 Income* (dollars)
Abilene, 1965	2200	2260
Amarillo, 1964	2520	2850
Austin, 1962	2240	2810
Brownsville, 1970	1480	1480
Bryan-College Station, 1970	2500	2500
Corpus Christi, 1963	1930	2470
Dallas, 1950	1580	3310
Dallas-Fort Worth, 1964	2660	3310
El Paso, 1958	1740	2190
El Paso, 1970	2190	2190
Galveston, 1964	2420	2840
Harlingen-San Benito, 1965	1290	1480
Houston, 1953	1810	3150
Jefferson-Orange, 1963	2340	2640
Laredo, 1964	1090	1500
Lubbock, 1964	2180	2540
McAllen-Pharr, 1967	1180	1490
San Angelo, 1964	2160	2470
San Antonio, 1956	1660	2400
San Antonio, 1969	2350	2400
Sherman-Denison, 1968	2370	2490
Texarkana, 1965	2220	2420
Tyler, 1964	2170	2590
Victoria, 1970	2200	2200
Waco, 1964	2220	2350
Wichita Falls, 1964	2200	2610

* All incomes in constant 1967 dollars

TABLE D-2: Estimated Median Per Capita Income (based on county data)

APPENDIX E

Analysis of Future Statewide Travel Data

Introduction

Increases in person trips per person and auto-driver trips per person are attributed to:

1. increases in travel resulting from a greater propensity to travel; and
2. increases in auto availability per capita.

A discussion of the propensity to travel is relevant to several sections of this report and is considered separately in Appendix G. The methodology and data used in predicting future statewide changes in auto availability per capita are presented below.

Auto Availability

Auto availability and usage per capita are influenced by the percentage of the population licensed to drive and by the ratio of registered motor vehicles to licensed drivers. Assuming, as a statewide average, that each auto generates a similar volume of trips, the increase in auto availability per capita will also be representative of an increase in person trips per person.

In estimating per capita auto availability for future years, the following data and assumptions were used:

1. Based on the historical data presented in Table E-1, it was assumed that eligible drivers would continue to constitute approximately 65% of the total population of Texas. Although the age distribution of the driving population may shift in the future, the percentage of the population eligible to drive will not change appreciably.

Year	Percentage of Population Eligible to Drive
1950	68
1960	64
1970	65

TABLE E-1: Eligible Drivers as a Percent of Total Population, Texas

2. Based on the historical data presented in Table E-2, it was assumed that the ratio of motor vehicles registered/licensed drivers would remain at approximately 1.05;

Year	Motor Vehicles Registered/Licensed Drivers
1950	1.10
1960	1.02
1970	1.05

TABLE E-2: Ratio of Motor Vehicles Reigstered to Licensed Drivers, Texas

3. It was assumed that a ratio of motor vehicles registered to licensed drivers of approximately 1.05 represents a saturation value for vehicle ownership. This assumption is consistent with that set forth in other studies (10, 11) concerning saturation auto ownership levels; and

4. Based on an extrapolation of historical trends as presented in Figure E-1, it was assumed that virtually all eligible drivers would be licensed by 1980.

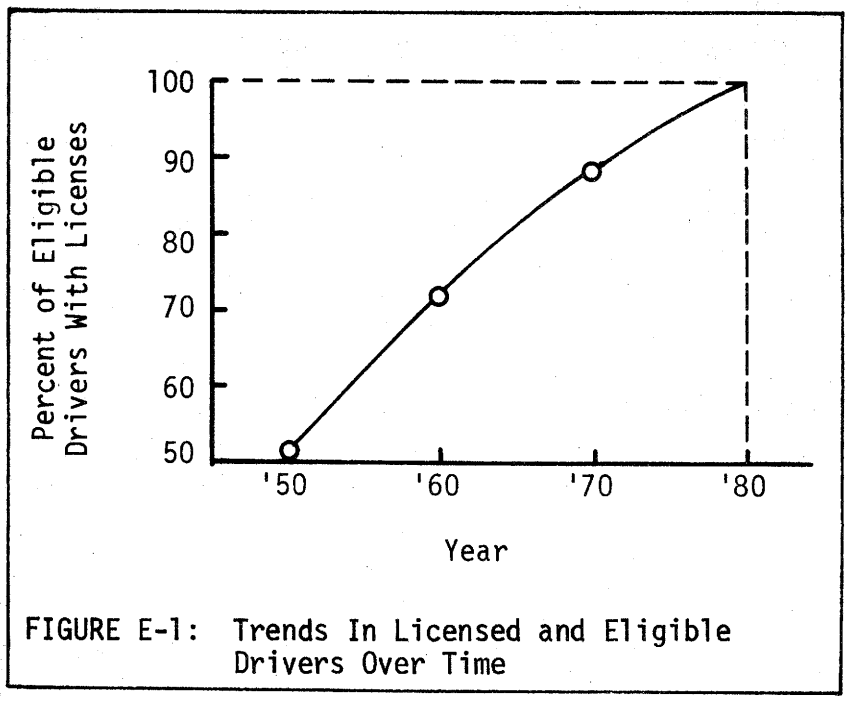

FIGURE E-1: Trends In Licensed and Eligible Drivers Over Time

Data relative to the rate of future increase in per capita auto availability, based on statewide data, are included in Table E-3.

Year	Licensed Drivers Per Capita	Motor Vehicles Per Capita	Annual % Increase Auto Availability Per Capita
1970	0.57	0.60	
1980	0.65	0.67	1.2
2000	0.65	0.67	0.0

TABLE E-3: Estimated Auto Availability, Texas

Auto availability per capita can be expected to increase at an annual rate of approximately 1.2% between 1970 and 1980. After 1980, this component will not contribute to further increases in per capita trip generation rates.

APPENDIX F

Future Trends in Individual Urban Areas

Introduction

Future increases in person trips per person and auto-driver trips per person are attributed to:

1. increases in travel resulting from a greater propensity to travel; and
2. increases in auto availability per capita.

A discussion of the propensity to travel is relevant to several sections of this report and is considered separately in Appendix G. The methodology and data use in projecting future changes in auto availability per capita are presented below.

Auto Availability

Per capita vehicle ownership has, historically, varied among the different groupings of urban areas (Table F-1). However, extrapolation indicates that all urban areas will experience a saturation level of vehicle ownership by 1980 (Figure F-1). As presented previously, 1.05 vehicles per licensed driver is assumed to be a saturation vehicle ownership level. Although saturation vehicle ownership will apparently exist in all urban areas by 1980, the rate of increase between 1970 and 1980 in per capita vehicle availability required to achieve saturation ownership will vary among the different study areas (Table F-2).

Type of Urban Area (Location, Population)	Estimated Vehicles Per Capita	
	1960	1970
North Texas, Population > 175,000	0.44	0.57
North Texas, Population < 175,000	0.46	0.59
South Texas, Population > 175,000	0.38	0.51
South Texas, Population < 175,000	0.30	0.49

TABLE F-1: Registered Vehicles Per Capita, Texas Study Areas

APPENDIX F

Future Trends in Individual Urban Areas

Introduction

Future increases in person trips per person and auto-driver trips per person are attributed to:

1. increases in travel resulting from a greater propensity to travel; and
2. increases in auto availability per capita.

A discussion of the propensity to travel is relevant to several sections of this report and is considered separately in Appendix G. The methodology and data use in projecting future changes in auto availability per capita are presented below.

Auto Availability

Per capita vehicle ownership has, historically, varied among the different groupings of urban areas (Table F-1). However, extrapolation indicates that all urban areas will experience a saturation level of vehicle ownership by 1980 (Figure F-1). As presented previously, 1.05 vehicles per licensed driver is assumed to be a saturation vehicle ownership level. Although saturation vehicle ownership will apparently exist in all urban areas by 1980, the rate of increase between 1970 and 1980 in per capita vehicle availability required to achieve saturation ownership will vary among the different study areas (Table F-2).

Type of Urban Area (Location, Population)	Estimated Vehicles Per Capita	
	1960	1970
North Texas, Population > 175,000	0.44	0.57
North Texas, Population < 175,000	0.46	0.59
South Texas, Population > 175,000	0.38	0.51
South Texas, Population < 175,000	0.30	0.49

TABLE F-1: Registered Vehicles Per Capita, Texas Study Areas

Assuming that increases in vehicle availability per capita are directly related to increases in internal person trips per person, those rates of increase in vehicle availability identified in Table F-2 will contribute directly to increased person and auto-driver trips per person.

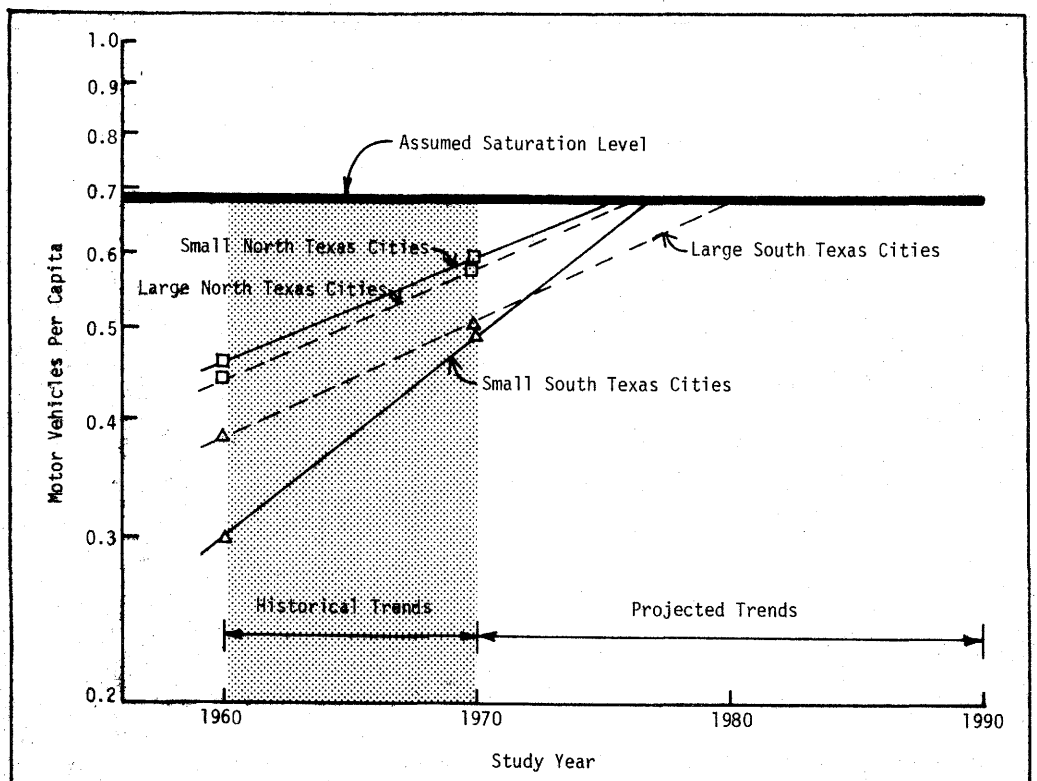

FIGURE F-1: Projected Vehicle Registration Per Capita, Texas Cities

Type of Urban Area (Location, Population)	Estimated Vehicles/Capita		Annual % Increase Vehicle/Capita
	1970	1980*	
North Texas, Population > 175,000	0.57	0.68	1.9
North Texas, Population < 175,000	0.59	0.68	1.5
South Texas, Population > 175,000	0.51	0.68	2.9
South Texas, Population < 175,000	0.49	0.68	3.3

* Represents assumed saturation level of vehicles per capita

TABLE F-2: Projected Increase, Vehicles Per Capita

APPENDIX G
The Propensity to Travel, A Discussion

Introduction

Apparently, persons in any given socioeconomic level are making more trips today than they have in the past. This greater trip making is the result of a changing lifestyle; changes in customs, cultural habits, and personal preferences all influence the per capita rate of trip making. This greater rate of trip making has been termed an increasing propensity to travel and suggests a desire on the part of the urban population for greater individual mobility.

Historical Trends

Statewide Trends

The increased propensity to travel can vary over time and is dependent on the level of urban accessibility. It appears that the average annual increase in the propensity to travel was approximately 1.5% per year during the 1960s. This implies that the urban populace has possessed, historically, a desire for greater personal mobility.

Trends in Individual Urban Areas

It was determined that the rate of increase in travel attributed to the propensity to travel varied between the urban areas (Table G-1). The propensity to travel in small North cities apparently increased at an annual rate of 2.9%. Due to the relatively high level of vehicles per capita in 1960 (0.46), a substantial portion of this increase can be assumed to actually represent an increase in the propensity to travel.

The increase in the propensity to travel for the large urban areas was significantly less than that for the small urban areas. If the rate of increase identified for the small urban areas can be assumed to represent the desire for travel on the part of the urban populace, it can be concluded that capacity-accessibility constraints in the large urban areas are apparently restraining the desired rate of per capita travel. If such is the case, it implies that

a latent demand for individual travel apparently exists in the large urban areas. This would aid in accounting for the congested nature of new freeways immediately following their opening; they are evidently serving a previously unidentified, unquantified desire for travel. If this unserved desire for travel does exist, it implies that future freeways can be expected to experience levels of congestion above those which are forecasted using conventional analyses.

Type of Urban Area (Location, Population)	Annual % Increase in the Propensity to Travel
North Texas, Population > 175,000	0.3
North Texas, Population < 175,000	2.9
South Texas, Population > 175,000	0.1
South Texas, Population < 175,000	3.3

TABLE G-1: Historical Trends In the Propensity to Travel, Texas (1960-1970)

Future Trends

Introduction

The future propensity to travel is highly dependent on the level of urban accessibility which will be provided in future years. Some planners have postulated that urban accessibility has already attained its maximum level and can be expected to decrease in the future. If such is the case, the propensity to travel would decrease and could even become a negative component of future travel demand.

This occurrence may be in the process of taking place in the large urban areas of Texas. It is reasonable to assume that the desire for greater per capita mobility is reasonably similar between the large and small urban areas. Since the apparent rate of increase in the propensity to travel is lower in the large urban areas, it suggests that capacity-accessibility constraints might be affecting the propensity to travel.

As a result, it appears as if there are two separate travel demands which need to be evaluated in future planning. The first would be the volume of traffic which will actually be observed on the transportation system; this volume will be

a function of the capacity of the transportation system provided. The second would be a volume of traffic which would be representative of travel volume if all travel desires were served. Failure to consider the desired rate of travel and the latent demand it can generate can result in underestimation of actual future travel.

It is logical to assume, however, that, even if all future travel desires were to be served, some saturation level of per capita trip making does exist. In the future analyses, it has been assumed that travel desire will continue to increase in the indefinite future. Future observation and monitoring will be necessary to identify the saturation level of trip making.

Statewide Trends

In the statewide future analysis, it was assumed that the propensity to travel would continue to increase at an annual rate of 1.5%; this represents a continuation of the rate of increase which apparently occurred during the 1960s.

Several significant changes could occur in this rate in future years. However, this rate of increase appears to represent a minimum level of desire for future increased mobility. As a result, it seems reasonable to recognize the level of trip making associated with desired travel since, if these trips are not made, it will apparently be the result of capacity-accessibility constraints in the transportation system.

Trends in Individual Urban Areas

It was assumed that the propensity to travel would increase at approximately 1.0% per year in the large urban areas and at 2.0% per year in the smaller urban areas. These rates of increase provide for serving at least a minimum level of increased travel desire. These values may be less than the actual travel desire, but may also be somewhat greater than the travel level which will be permitted by the transportation system.

The future rates of increase attributed to the propensity to travel suggested herein are based on a review of the historical trends. With the data available, it is not possible to precisely quantify the rate of increase in trip generation for future years that is due to the greater propensity to travel. The rates projected herein appear to be reasonable for application in the transportation

planning process. Such rates account for serving at least a minimum level of the increased desire for individual mobility.

Conclusion

It should be emphasized that the propensity to travel is a very dynamic quantity and is subject to significant change over time. The traffic volume which will actually occur at some future date will be a direct function of the capacity of the transportation system. In planning, it should be realized that the desired level of trip making may be substantially greater than the observed rate of trip making at any point in time.